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CROSS-SECTIONAL EVALUATION OF RETINAL CHANGES IN PATIENTS WITH UNCONTROLLED HYPERTENSION.

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Abstract

Background

Hypertension is a major global public health issue and a leading contributor to cardiovascular disease and stroke. Uncontrolled hypertension significantly affects microvascular structures, particularly in the retina, where visible alterations in the vasculature—termed hypertensive retinopathy—can serve as a non-invasive and early indicator of systemic vascular health. Regular retinal evaluations in hypertensive patients may offer vital clinical insights into the extent of end-organ damage and guide therapeutic interventions.

Objective

This study aimed to assess the prevalence and severity of retinal changes in patients with uncontrolled hypertension and examine correlations with clinical parameters such as age, duration of hypertension, and blood pressure severity.

Methods

A one-year cross-sectional observational study was conducted involving 100 patients diagnosed with uncontrolled hypertension (systolic BP >140 mmHg and/or diastolic BP >90 mmHg despite treatment). Fundus examinations were performed using both direct and indirect ophthalmoscopy, and retinal changes were classified according to the Keith-Wagener-Barker grading system. Clinical data including patient demographics, blood pressure readings, and duration of hypertension were collected and analyzed using SPSS software.

Results

Of the 100 participants, 62% were male, with the highest proportion (34%) aged between 51–60 years. The mean age was 58.2 ± 10.3 years, and the mean duration of hypertension was 8.6 ± 4.2 years. Retinal changes were present in 82% of the patients: 28% had Grade I, 32% Grade II, 18% had Grade III, and 4% had Grade IV hypertensive retinopathy. Significant associations were found between the severity of retinal changes and increasing age, longer disease duration, and higher blood pressure levels ($p < 0.05$).

Conclusion and Recommendation

The study highlights a strong correlation between hypertensive retinopathy and disease severity. Routine fundoscopic examinations should be integrated into hypertension management protocols to facilitate early detection of complications and improve patient outcomes.

Keywords: *Hypertension, hypertensive retinopathy, retinal changes, fundus examination, cross-sectional study.*
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Introduction

Worldwide, hypertension is a prevalent non-communicable disease [1]. Hypertension, which is defined by the World Health Organisation as a persistent increase in systolic blood pressure of 140 mm Hg or higher and/or diastolic blood pressure of 90 mm Hg or higher, affects more than 1.28 billion people globally, mostly in low- and middle-income nations [2]. Public health is threatened by this circumstance. It's called the "silent killer" because it doesn't show symptoms until it destroys vital organs including the brain, eyes, heart, and kidneys. Hypertension is rising due to rapid urbanization, inactivity, bad diet, obesity, and

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increased life expectancy [3]. The World Health Organisation states that over half of hypertensives are unaware of their condition and even fewer receive therapy. Uncontrolled hypertension causes most cardiovascular, stroke, chronic renal, and hypertensive retinopathy deaths and disabilities [4]. Due to demographic and lifestyle changes, India's already high adult hypertension rate is anticipated to rise from 25% to 30%.

Hypertension damages the organism through endothelial dysfunction, increased vascular permeability, and arterial wall structural changes [5]. This causes target organ damage, reduced tissue perfusion, and arteriosclerosis over time. As the only organ with visible blood arteries, the retina is one of the first and most obvious symptoms of microvascular injury [6]. Chronic hypertension causes retinal vasoconstriction, arteriosclerosis, and vascular permeability. Vasospasm, arteriolar narrowing, is the initial reaction to elevated blood pressure. Prolonged hypertension causes arterial wall thickening and hyaline degeneration [7]. AV nicking, copper or silver wire, and flame-shaped hemorrhages result from these changes. Exudates, cotton wool patches, and papilledema indicate severe end-organ damage that could be fatal. Systemic blood pressure changes greatly affect retinal microvasculature. Because the retina lacks a dual blood supply, even slight variations in perfusion pressure can trigger retinal ischemia or hemorrhagic events. Thus, in hypertension patients, retinal vessels accurately indicate microvascular system health and illness progression.

Fundoscopic examinations, a rare chance, show how systemic hypertension affects microcirculation. The retina provides a direct, non-invasive, and cost-effective means to detect early hypertension changes, unlike the heart or kidneys, which require specialized and often intrusive diagnostic devices [8,9]. Retinal examinations, especially with modern imaging technologies like OCT or digital fundus photography, can reveal hypertension-related vascular changes. These changes predict stroke and myocardial infarction and affect hypertension severity and duration. Multiple population-based studies link hypertensive retinopathy to cardiovascular death. Beaver Dam Eye and ARIC investigations are examples [10,11]. By detecting retinal changes in hypertensive patients, doctors can assess therapy efficacy and promote medication adherence. Retinopathy might prompt patients and doctors to lower blood pressure to prevent systemic complications.

Standardizing hypertensive retinal changes evaluation has been proposed using several grading techniques. Popular systems include the 1939 Keith-Wagener-Barker (KWB) system. This approach divides hypertensive retinopathy into four levels based on fundoscopic severity:

- **Grade I:** Sclerosis or mild generalized atherosclerosis of the arteries.
- **Grade II:** Arteriovenous nicking and localized constriction are more noticeable symptoms of arteriolar narrowing.
- **Grade III:** Presence of retinal hemorrhages, cotton wool spots, and hard exudates, in addition to arteriolar changes.
- **Grade IV:** Severe grade with optic disc swelling (papilledema), indicating malignant hypertension.

This taxonomy establishes a framework but is limited by subjective interpretation and inter-observer variability. It's still useful, especially in low-resource areas without advanced imaging methods. New categorization approaches for fundus photography using artificial intelligence (AI) aim to increase accuracy and reproducibility in research and clinical settings. To assess the retinal changes in patients with uncontrolled hypertension and evaluate their clinical significance. To grade hypertensive retinopathy based on standardized criteria in patients with uncontrolled hypertension. To analyze the correlation between retinal changes and patient-related variables such as age, duration of hypertension, severity of blood pressure elevation

Materials and Methods

Study Design and Duration

This study was designed as a cross-sectional observational study conducted over a period of one year from January 2023 to December 2023. The objective was to evaluate and grade retinal changes in patients with uncontrolled hypertension and to analyze their association with patient-

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related factors such as age, duration of hypertension, and the severity of blood pressure.

Sample Size and Population

A total of 100 patients with uncontrolled hypertension were enrolled in the study. The sample size was determined based on a prevalence rate of hypertensive retinopathy reported in previous Indian studies (ranging from 60–80%) and using a confidence level of 95% and a margin of error of 10%. Additionally, feasibility factors such as patient availability, duration of the study, and resources available at the institution were considered to arrive at this practical and statistically acceptable sample size.

Inclusion Criteria

The research included affected people with a history of hypertension who were 18 years old or older and whose blood pressure measurements remained consistently high even after medication. If the average of three measurements taken during the clinical visit was more than 90 mmHg or systolic blood pressure was more than 140 mmHg, then the patient was considered to have uncontrolled hypertension.

Exclusion Criteria

To minimize bias and avoid interference from other ocular or systemic conditions known to cause retinal pathology, patients with the following conditions were excluded from the study: diabetic retinopathy, glaucoma, high myopia (defined as refractive error >6 diopters), or any other pre-existing ocular pathologies that could potentially influence the retinal findings. Patients with a history of ocular trauma or recent ocular surgeries were also excluded.

Data Collection

All volunteers underwent a thorough clinical and ophthalmological evaluation. Blood pressure was measured with a conventional digital sphygmomanometer. We took three five-minute sitting readings to get the mean. Visual acuity was measured with a Snellen chart. A complete fundus examination was performed in a dark room using direct and indirect ophthalmoscopy after pupil dilation. Sometimes a non-mydriatic fundus camera was used to document and grade retinal images. The Keith-Wagener-Barker (KWB) grading system classified retinal hypertensive retinopathy changes. We also collected each patient's gender, age, years of hypertension, and antihypertensive drug use using a pre-structured data collection form.

Ethical Clearance

The study was approved by the Institutional Ethics Committee (IEC) before it began. Before enrolling, we made sure everyone knew what the study was going to be about and got their written informed permission.

Statistical Analysis

The collected data was organized and analyzed using SPSS, which stands for Statistical Package for the Social Sciences. The use of descriptive statistics allowed for the summarisation of clinical and socioeconomic aspects. A p-value below 0.05 was considered statistically significant for all investigations.

Results

Demographic Characteristics

A total of 100 patients with uncontrolled hypertension were enrolled in the study. The age of participants ranged from 35 to 80 years, with a mean age of **58.2 ± 10.3 years**. The majority of patients were in the age group of 51–60 years (34%). Out of the total, **62 were male (62%)** and **38 were female (38%)**, indicating a male preponderance. The **mean duration of hypertension** among the study population was **8.6 ± 4.2 years**.

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Table 1: Demographic detail of Participants

Variable	Category	Frequency (n = 100)	Percentage (%)
Age group (years)	35–40	8	8
	41–50	18	18
	51–60	34	34
	61–70	28	28
	>70	12	12
Gender	Male	62	62
	Female	38	38
Duration of HTN	<5 years	26	26
	5–10 years	44	44
	>10 years	30	30

Blood Pressure Distribution

In this study, the average values for systolic blood pressure (SBP) and diastolic blood pressure (DBP) were 158.4 ± 12.8 and 96.7 ± 7.4 mmHg, respectively. Readings from all patients were in line with hypertension that was not under control. The results of the fundus examination showed that hypertensive retinopathy was present in 82% of the patients. As per the classification proposed by Keith-Wagener-Barker:

Table 2: Distribution of Hypertensive Retinopathy Grades

Grade of Retinopathy	Number of Patients	Percentage (%)
Grade 0	18	18
Grade I	28	28
Grade II	32	32
Grade III	18	18
Grade IV	4	4

Correlation Analysis

There was a statistically significant positive correlation among age and severity of hypertensive retinopathy (p = 0.021). Older age groups (>60 years) had a higher proportion of Grade III and IV changes. A important correlation was noted between the period of hypertension and the grade of retinopathy (p = 0.008). Patients with hypertension duration >10 years were more likely to have Grade II and above changes. Higher SBP and DBP levels were significantly associated with advanced grades of hypertensive retinopathy (p < 0.001). Patients with SBP >160 mmHg had more frequent Grade III and IV changes.

Table 3: Correlation Between Clinical Parameters and Retinopathy Grades

Parameter	Grade 0–I (n = 46)	Grade II–IV (n = 54)	p-value
Mean Age (years)	54.1 ± 8.9	61.2 ± 9.4	0.021*
Mean Duration of HTN (yrs)	6.3 ± 2.8	9.7 ± 4.3	0.008*
Mean SBP (mmHg)	150.2 ± 9.5	165.3 ± 11.2	<0.001*
Mean DBP (mmHg)	92.4 ± 6.1	100.8 ± 5.9	<0.001*

**Statistically significant (p < 0.05)*

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Hypertensive retinopathy was present in 82% of patients with uncontrolled hypertension. The most common grades observed were Grades I and II. Advancing age, longer duration of hypertension, and higher blood pressure levels were significantly associated with more severe retinal changes.

Discussion

Hypertensive retinopathy is a well-recognized manifestation of systemic hypertension, serving as a window into the state of systemic microvascular damage. The retina provides a unique and non-invasive means of observing the consequences of chronic hypertension, particularly in uncontrolled cases. This study aimed to evaluate and grade retinal changes in patients with uncontrolled hypertension and explore the correlation of these changes with patient age, duration of hypertension, and the severity of blood pressure elevation. The findings from our study offer both clinical and public health insights.

Overview of Key Findings

In this study, hypertensive retinopathy was found in a significant proportion of patients with uncontrolled hypertension, with the severity of retinal changes increasing with age, longer duration of hypertension, and higher blood pressure levels. The most frequently observed fundus changes were arteriovenous crossing changes, generalized and focal arteriolar narrowing, and hemorrhages in advanced grades. The Keith-Wagener-Barker classification was effectively used to grade hypertensive retinopathy. Most patients presented with grade I or II changes; however, a noteworthy subset showed grade III or IV changes, indicating severe and chronic hypertension. This finding underscores the importance of routine fundus examinations, especially in patients with poorly controlled blood pressure.

Correlation with Demographic and Clinical Parameters

A significant positive correlation was observed between increasing age and the severity of hypertensive retinopathy, which is consistent with the pathophysiology of vascular aging and cumulative exposure to elevated blood pressure. Similarly, patients with a longer duration of hypertension were more likely to exhibit higher grades of retinopathy, affirming the chronic degenerative impact of persistent hypertension on the retinal vasculature. Another notable finding was the correlation between higher systolic and diastolic blood pressure and the severity of retinopathy. These results align with previous epidemiological studies conducted both in India and internationally, which have demonstrated that the retinal vascular system reflects systemic hemodynamic status and cumulative end-organ damage.

Clinical and Public Health Implications

These findings hold critical implications for primary care physicians, ophthalmologists, and public health practitioners. The retina can act as an indicator of hypertensive end-organ damage, enabling early detection and timely intervention. In resource-limited settings like India, routine ophthalmoscopy in hypertensive patients can serve as a low-cost, effective screening tool to identify high-risk individuals who may also have subclinical damage to other organs such as the kidneys or brain [13] & [14]. Furthermore, patient awareness and adherence to antihypertensive medications remain a major challenge in the Indian healthcare context [15]. Our study reinforces the need for robust hypertension management programs that include ocular screening as part of a comprehensive approach to chronic disease care.

Generalizability

While the findings of this study are significant, they must be interpreted within the context of its design and setting. The study was conducted at a tertiary care center, which may attract more severe or complicated cases, possibly overestimating the prevalence and severity of retinopathy compared to the general hypertensive population. Moreover, patients from urban and semi-urban settings were predominantly represented. Hence, caution should be exercised while generalizing these results to rural populations or those with better-controlled hypertension. Nevertheless, since RIMS, Ranchi serves a wide catchment area and caters to a socioeconomically diverse population, the results provide valuable insight into real-world patient profiles. The grading system used is universally accepted, adding to the external validity of our results.

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Limitations

Despite the strength of its observational design and clinical relevance, the study has several limitations. Limits the geographical and ethnic diversity of the sample. Cross-sectional nature Prevents establishing temporal or causal relationships between hypertension control and retinal outcomes. Subjective grading bias although standardized, the Keith-Wagener-Barker classification involves some degree of subjective interpretation. Lack of follow-up data longitudinal analysis would have better revealed the progression or regression of retinal changes following blood pressure control. Exclusion of comorbidities Patients with diabetes and other ocular diseases were excluded, limiting insights into multifactorial retinopathy.

Recommendations

Hypertensive patients, especially those with uncontrolled BP or long-standing disease, should undergo periodic fundus examination for early detection of retinopathy. Ophthalmologists and physicians should collaborate in multidisciplinary clinics for chronic disease management, integrating eye screening into general health check-ups. Public health campaigns must emphasize the ocular complications of hypertension, highlighting the silent but serious nature of hypertensive retinopathy. Multicentric, longitudinal studies are needed to assess the impact of interventions on retinopathy progression and to include a broader demographic base, including rural populations. The inclusion of non-mydriatic fundus cameras at primary health centers could enhance screening in resource-poor settings.

Conclusion

In conclusion, this study highlights that retinal changes are a joint finding in individuals with uncontrolled hypertension, with the majority exhibiting varying degrees of hypertensive retinopathy. These retinal alterations serve as visible indicators of underlying systemic vascular damage, reflecting the broader impact of sustained high blood pressure on end organs. The use of fundus examination, a simple, non-invasive, and cost-effective diagnostic tool, proves to be invaluable in the early detection and grading of hypertensive retinopathy. Identifying such changes at an early stage can prompt timely intervention, thereby potentially preventing serious cardiovascular, renal, or neurological complications. Given the high prevalence observed and the ease of retinal assessment, the study strongly advocates for routine ophthalmic evaluation as part of the clinical management protocol for all patients with uncontrolled hypertension. This approach not only enhances overall patient care but also contributes to long-term systemic risk reduction through multidisciplinary involvement.

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Lists of abbreviations

KWB- Keith-Wagener-Barker

OCT- Optical coherence tomtomograpy

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Conflict of interest

The Author declares no conflict of interest.

Author Biography

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Author Contribution

Dr. Nitish Kumar Marshal– Data collection, drafting and interpretation and finalising and final editing of this manuscript.

Dr .Rahul Prasad – Drafting supervise and proofread of this manuscript.

Dr. Komal Soni- Finalize, conceptualized, briefings corrections and final editing this manuscript.

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