International Journal of Medicine
pISSN 1468-3814 | eISSN 2667-7008
https://theinternationalmedicine.com/

Original Researcher Article *DOI: 10.61336/im/26-2-12*

Retinal Vascular Changes as Predictors of Subclinical Atherosclerosis and Cardiovascular Risk: A Prospective Observational Study.

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Received: 07-03-2026
Revised: 23-03-2026
Accepted: 16-04-2026
Published: 22-04-2026

Abstract

Background: Early detection of subclinical atherosclerosis remains a cornerstone in preventing cardiovascular morbidity and mortality. Retinal vasculature, being the only directly visualizable microcirculation, provides a unique window into systemic vascular health. This study aimed to prospectively evaluate retinal vascular changes as predictors of subclinical atherosclerosis and cardiovascular risk. ***Methods:*** A prospective observational study was conducted over 18 months involving 150 asymptomatic adults aged 30–65 years attending a tertiary care center. Comprehensive ophthalmic examination including fundus photography and optical coherence tomography angiography (OCTA) was performed. Retinal vascular parameters assessed included arteriolar narrowing, venular dilatation, arteriovenous (AV) nicking, retinopathy lesions, and vessel density. Subclinical atherosclerosis was evaluated using carotid intima-media thickness (CIMT) and carotid plaque assessment. Cardiovascular risk was estimated using standard risk scoring systems. ***Results:*** Retinal vascular abnormalities were significantly associated with increased CIMT and presence of carotid plaques ($p < 0.001$). Reduced OCTA vessel density showed strong correlation with elevated cardiovascular risk scores ($r = -0.62$). Generalized arteriolar narrowing and venular dilatation were independent predictors of subclinical atherosclerosis (adjusted OR: 2.8 and 2.4 respectively). Combining retinal parameters with traditional risk models improved predictive accuracy by 18%. ***Conclusion:*** Retinal vascular changes serve as significant non-invasive predictors of subclinical atherosclerosis and cardiovascular risk. Integration of retinal imaging into cardiovascular screening protocols may enhance early detection and risk stratification.

Keywords: Retinal vasculature, Subclinical atherosclerosis, Cardiovascular risk, OCTA, CIMT, Oculomics.

INTRODUCTION

Cardiovascular diseases (CVD) remain the leading cause of mortality worldwide. Atherosclerosis is a progressive disease that often remains clinically silent until advanced stages. Identification of subclinical atherosclerosis is therefore critical for early intervention.

The retinal microvasculature shares anatomical and physiological similarities with systemic circulation. Retinal vascular changes reflect endothelial dysfunction, microvascular damage, and systemic vascular remodeling. Advances in retinal imaging, particularly OCT angiography (OCTA), have enabled precise quantification of microvascular parameters. Emerging evidence supports the concept of "oculomics," wherein retinal biomarkers can predict systemic diseases, including cardiovascular disorders. However, prospective data validating retinal vascular changes as predictors of subclinical atherosclerosis remain limited.

This study aims to prospectively evaluate the association between retinal vascular changes and markers of subclinical atherosclerosis, and to assess their utility in cardiovascular risk prediction.

MATERIALS AND METHODS

Study Design

Prospective observational study conducted over 18 months at Santosh Medical College, Ghaziabad.

Study Population

- Sample size: 150 participants
- Age group: 30–65 years
- Inclusion: Asymptomatic individuals attending outpatient services
- Exclusion: Known cardiovascular disease, diabetic retinopathy, ocular media opacity, prior ocular surgery, systemic inflammatory diseases

Clinical Assessment
- Detailed history including hypertension, diabetes, smoking, dyslipidemia
- Blood pressure measurement
- BMI calculation
- Laboratory investigations (lipid profile, fasting glucose)

Ophthalmic Evaluation
- Visual acuity assessment
- Fundus examination
- Fundus photography
- OCTA for vessel density analysis

Retinal Parameters Assessed
- Generalized arteriolar narrowing
- Venular dilatation
- Arteriovenous nicking
- Focal arteriolar narrowing
- Retinopathy lesions (microaneurysms, hemorrhages)
- Vessel density (superficial and deep plexus)

Assessment of Subclinical Atherosclerosis
- Carotid intima-media thickness (CIMT) via ultrasonography
- Presence of carotid plaques

Cardiovascular Risk Assessment
- Framingham Risk Score

Statistical Analysis
- Data analyzed using SPSS
- Pearson correlation for associations
- Logistic regression for predictors
- $p < 0.05$ considered significant

RESULTS

Baseline Characteristics
- Mean age: 48.2 ± 9.6 years
- Male: 58%, Female: 42%
- Hypertension: 32%
- Diabetes: 28%

Retinal Findings
- Arteriolar narrowing: 40%
- Venular dilatation: 35%
- AV nicking: 22%
- Retinopathy lesions: 18%
- Reduced vessel density: 45%

Association with CIMT
- Mean CIMT significantly higher in patients with retinal changes (0.89 mm vs 0.64 mm, $p < 0.001$)
- Carotid plaques present in 30% of patients with abnormal retinal findings

Correlation Analysis
- Vessel density vs cardiovascular risk score: $r = -0.62$
- Arteriolar narrowing vs CIMT: $r = 0.55$
- Venular dilatation vs CIMT: $r = 0.48$

Regression Analysis

- Arteriolar narrowing: OR 2.8 (95% CI: 1.6–4.9)
- Venular dilatation: OR 2.4 (95% CI: 1.3–4.2)
- Reduced vessel density: OR 3.2 (95% CI: 1.9–5.5)

Predictive Model

Adding retinal parameters to traditional risk scoring improved prediction accuracy by 18%.

DISCUSSION

This prospective study demonstrates a strong association between retinal vascular abnormalities and subclinical atherosclerosis. The findings support the hypothesis that retinal microvascular changes reflect systemic vascular pathology. Generalized arteriolar narrowing likely represents chronic hypertensive damage and increased vascular resistance, while venular dilatation is associated with inflammation and endothelial dysfunction. AV nicking reflects vascular remodeling and compression effects.

OCTA-derived vessel density emerged as a powerful predictor of cardiovascular risk. Reduced microvascular perfusion may indicate early ischemic changes and impaired autoregulation.

The correlation between retinal findings and CIMT suggests that retinal imaging could serve as a surrogate marker for early atherosclerosis. Importantly, combining retinal biomarkers with traditional risk models significantly enhanced predictive capability.

Clinical Implications

- Non-invasive, rapid screening tool
- Potential for mass screening using fundus imaging
- Integration with AI for automated risk prediction

Limitations

- Single-center study
- Moderate sample size
- Lack of long-term follow-up for cardiovascular events

Future **Directions**

- Multicentric longitudinal studies
- Integration of AI-based retinal analysis
- Development of standardized retinal risk scoring systems.

CONCLUSION

Retinal vascular changes are significant predictors of subclinical atherosclerosis and cardiovascular risk. Retinal imaging, particularly with OCTA, holds promise as a non-invasive tool for early cardiovascular risk stratification. Incorporation of retinal biomarkers into routine screening protocols could improve early detection and preventive strategies.

REFERENCES

1. Wong TY, Klein R, Klein BE. Retinal microvascular abnormalities and their relationship with hypertension, cardiovascular disease, and mortality. Surv Ophthalmol.
2. Ikram MK, Ong YT, Cheung CY. Retinal vascular caliber measurements and cardiovascular disease risk. Prog Retin Eye Res.
3. Cheung CY, Ikram MK, Chen C. Imaging retina to study dementia and stroke. Prog Retin Eye Res.
4. Seidelmann SB, et al. Retinal vessel calibers and risk of coronary artery disease. Circulation.
5. Yau JW, et al. Retinal microvascular signs and risk of stroke. Ophthalmology.
6. Spaide RF, et al. Optical coherence tomography angiography. Retina.
7. McGeechan K, et al. Meta-analysis of retinal vessel caliber and cardiovascular risk. JAMA.
8. Sabanayagam C, et al. Retinal vascular imaging and cardiovascular disease. Lancet Diabetes Endocrinol.
9. Sharrett AR, et al. Retinal arteriolar narrowing and cardiovascular events. Atherosclerosis.
10. Poplin R, et al. Deep learning for retinal image analysis in cardiovascular risk prediction. Nat Biomed Eng.