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Anatomical Correlation Between Retinal Microvasculature and Coronary Artery Disease in a Pakistani Population.

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ABSTRACT

Background: The retinal microvasculature shares structural and physiological similarities with the coronary circulation and may provide a non-invasive window to assess systemic vascular pathology. Retinal vascular changes have increasingly been investigated as potential indicators of cardiovascular disease. This study aimed to evaluate the association between retinal microvascular anatomical changes and coronary artery disease (CAD) in a Pakistani population.

Methods: A cross-sectional study was conducted at a tertiary care hospital in Pakistan including 120 participants aged 40–70 years. Sixty patients with angiographically confirmed coronary artery disease were included in the case group, while sixty age- and sex-matched individuals without known cardiovascular disease served as controls. Fundus examination and digital retinal photography were performed to assess retinal vascular parameters including arteriolar narrowing, arteriovenous (AV) nicking, vascular tortuosity, and retinal hemorrhages. Data were analyzed using descriptive and comparative statistical methods.

Results: Retinal vascular abnormalities were significantly more frequent in patients with CAD compared with controls. Arteriolar narrowing was observed in 38 patients (63.3%) in the CAD group compared to 14 individuals (23.3%) in the control group. AV nicking was present in 31 patients (51.7%) with CAD versus 11 controls (18.3%). Increased retinal vascular tortuosity was detected in 26 CAD patients (43.3%) compared to 9 individuals (15.0%) in the control group. Retinal hemorrhages were identified in 12 patients (20.0%) with CAD, while only 3 participants (5.0%) in the control group demonstrated similar findings. The presence of multiple retinal microvascular changes was significantly associated with established coronary artery disease.

Conclusion: Retinal microvascular anatomical changes were markedly more prevalent in patients with coronary artery disease in this Pakistani cohort. These findings support the concept that retinal vascular examination may serve as a useful, non-invasive tool for identifying individuals at increased risk of cardiovascular disease. Incorporating retinal vascular assessment into routine clinical evaluation may enhance early detection and risk stratification in populations with high cardiovascular burden..

Keywords: Retinal microvasculature anatomy, Coronary artery disease, Fundus photography, Cardiovascular risk assessment

INTRODUCTION

Cardiovascular diseases remain a leading cause of morbidity and mortality worldwide, with coronary artery disease (CAD)

accounting for a substantial proportion of these deaths [1]. Early identification of vascular changes is crucial for timely intervention and prevention of adverse cardiac events [2]..

The microvascular system plays an essential role in maintaining adequate tissue perfusion and vascular health. Structural alterations within small vessels may reflect systemic vascular pathology and contribute to the development of cardiovascular disease [3]. The retinal vasculature offers a unique opportunity to directly visualize microcirculation in vivo using non-invasive imaging techniques [3,4].

The retina and coronary circulation share common embryological origins and physiological characteristics, including similar autoregulatory mechanisms and susceptibility to endothelial dysfunction [4]. Because of these similarities, changes in the retinal microvasculature may mirror pathological processes occurring within coronary vessels [5].

Several epidemiological studies have demonstrated associations between retinal vascular abnormalities and systemic cardiovascular risk factors such as hypertension, diabetes mellitus, and dyslipidemia [6]. Retinal findings such as arteriolar narrowing, arteriovenous (AV) nicking, and vascular tortuosity have been linked to increased risk of cardiovascular morbidity [7].

Advances in retinal imaging technologies, including digital fundus photography and optical coherence tomography angiography, have improved the ability to quantify subtle microvascular alterations [8]. These developments have strengthened the role of retinal vascular assessment as a potential biomarker for cardiovascular disease.

In populations with high cardiovascular risk, such as South Asians, early detection strategies are particularly important. Pakistan has witnessed a significant rise in cardiovascular disease prevalence due to urbanization, lifestyle changes, and increasing metabolic risk factors [9].

Despite growing international evidence supporting the association between retinal microvascular changes and cardiovascular disease, limited research has been conducted in Pakistani populations. Therefore, this study aimed to evaluate the anatomical correlation between retinal microvascular changes and coronary artery disease in a Pakistani cohort [10].

METHODS

A cross-sectional analytical study was conducted at a tertiary care hospital in Pakistan over a six-month period to evaluate retinal microvascular changes in individuals with coronary artery disease. The study included a total of 120 participants aged between 40 and 70 years. Participants were divided into two groups: Group A (CAD group), consisting of 60 patients with angiographically confirmed coronary artery disease, and Group B (control group), comprising 60 age- and sex-matched individuals without known cardiovascular disease. The inclusion criteria were age between 40 and 70 years, confirmed diagnosis of coronary artery disease for the case group, and willingness to provide informed consent to participate in the study. Participants were excluded if they had advanced diabetic retinopathy, glaucoma, ocular media opacity preventing proper fundus examination, or a history of previous retinal surgery. Retinal imaging was performed using digital fundus photography after pharmacological pupillary dilation. The retinal microvascular parameters evaluated included arteriolar narrowing, arteriovenous (AV) nicking, retinal vascular tortuosity, and retinal hemorrhages. Data were analyzed using statistical software, where descriptive statistics were calculated for demographic variables. Differences between the study groups were assessed using appropriate statistical tests, and a p-value of less than 0.05 was considered statistically significant.

RESULTS

Among the 120 participants, the mean age was comparable between both groups, and the gender distribution was similar.

Retinal vascular abnormalities were significantly more common in patients with coronary artery disease compared with controls. Arteriolar narrowing was observed in 38 patients (63.3%) in the CAD group compared with 14 individuals (23.3%) in the control group. AV nicking was present in 31 CAD patients (51.7%) while only 11 participants (18.3%) in the control group demonstrated similar findings.

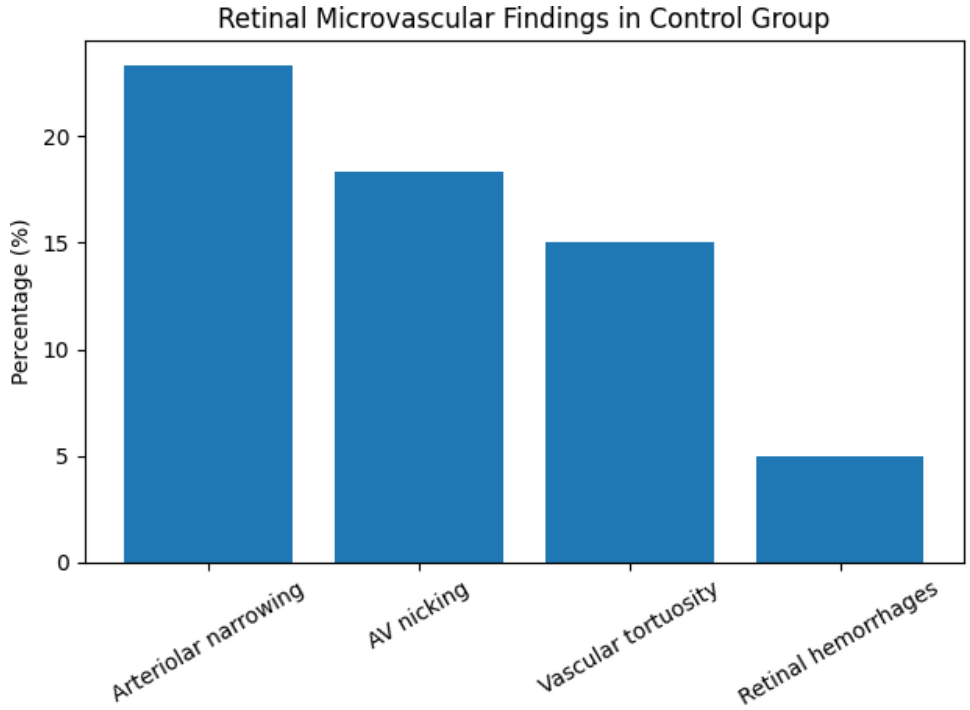
Increased retinal vascular tortuosity was identified in 26 CAD patients (43.3%) compared to 9 individuals (15.0%) among controls. Retinal hemorrhages were detected in 12 patients (20.0%) with CAD, whereas only 3 participants (5.0%) in the control group showed these abnormalities. Overall, the presence of multiple retinal microvascular changes was significantly associated with angiographically confirmed coronary artery disease.

Table 1:Baseline Characteristics

Variable	CAD Group (n=60)	Control Group (n=60)
Mean Age (years)	56.4 ± 7.2	55.8 ± 6.9
Male (%)	65%	63%
Female (%)	35%	37%

Table 2: Retinal Microvascular Findings

Retinal Finding	CAD Patients (n=60)	Controls (n=60)
Arteriolar narrowing	38 (63.3%)	14 (23.3%)
AV nicking	31 (51.7%)	11 (18.3%)
Vascular tortuosity	26 (43.3%)	9 (15.0%)
Retinal hemorrhages	12 (20.0%)	3 (5.0%)



DISCUSSION

The present study demonstrated a significant association between retinal microvascular abnormalities and coronary artery disease in a Pakistani population. Patients with CAD exhibited a markedly higher prevalence of retinal vascular alterations compared with individuals without cardiovascular disease. Retinal microvascular abnormalities have previously been recognized as indicators of systemic vascular dysfunction [9]. Structural changes such as arteriolar narrowing and AV nicking are often manifestations of chronic hypertension and endothelial damage, which are key contributors to coronary artery disease [11].

Large epidemiological studies have shown that retinal vascular changes may predict cardiovascular events, including myocardial infarction and stroke [12]. These findings support the concept that retinal microvascular assessment can provide valuable information regarding systemic vascular health. The observed increase in retinal vascular tortuosity among CAD patients in the present study may reflect chronic hemodynamic stress and vascular remodeling [13]. Such changes are believed to occur due to prolonged exposure to cardiovascular risk factors. Retinal hemorrhages were also more frequently observed in patients with CAD. Microvascular fragility and endothelial dysfunction may contribute to these findings, further highlighting the systemic nature of vascular disease [14].

Previous studies conducted in Western populations have demonstrated similar associations between retinal vascular abnormalities and cardiovascular disease [15]. However, South Asian populations are known to have a higher predisposition to cardiovascular disease at younger ages, making early detection particularly important. The findings of the current study align with earlier research suggesting that retinal imaging may serve as a non-invasive tool for cardiovascular risk stratification [16]. Routine retinal examinations may help identify individuals who require further cardiovascular evaluation. In addition, retinal vascular analysis may complement traditional cardiovascular risk factors such as hypertension, diabetes, and lipid abnormalities [17,18]. Combining retinal imaging with established risk assessment tools may improve prediction models for cardiovascular disease.

Recent advances in artificial intelligence and retinal imaging technologies may further enhance the clinical applicability of retinal vascular analysis in cardiovascular medicine [19,20]. However, the study has certain limitations, including a relatively small sample size and cross-sectional design. Longitudinal studies are required to establish causal relationships and evaluate the predictive value of retinal vascular changes for future cardiovascular events [21].

Despite these limitations, the study provides important preliminary data regarding the association between retinal microvascular abnormalities and coronary artery disease in a Pakistani population. Further multicenter studies with larger sample sizes are recommended to validate these findings and explore their clinical implications.

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Authors' Contribution:

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REFERENCES

1. World Health Organization. Cardiovascular diseases (CVDs). Available from: https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases(cvds)

2. Safiri S, Karamzad N, Singh K, Carson-Chahhoud K, Adams C, Nejadghaderi SA, et al. Global burden of ischemic heart disease and its attributable risk factors from 1990 to 2019. Lancet Reg Health Eur. 2021;3:100138.

3. Poplin R, Varadarajan AV, Blumer K, Liu Y, McConnell MV, Corrado GS, et al. Prediction of cardiovascular risk factors from retinal fundus photographs using deep learning. Nat Biomed Eng. 2021;5(1):35-45.

4. Cheung CY, Ikram MK, Sabanayagam C, Wong TY. Retinal microvasculature as a model to study the manifestations of systemic vascular diseases. Prog Retin Eye Res. 2021;82:100907.

5. Rusu AC, Horvath KU, Tinica G, Bulgaru-Iliescu A. Retinal structural and vascular changes in patients with coronary artery disease: A systematic review and meta-analysis. Life (Basel). 2024;14(4):448.

6. Zhang W, Guo X, Jiang X, Han X. Retinal microvascular changes and risk of coronary heart disease: A systematic review and meta-analysis. Retina. 2024;44(2):256-264.

7. Yao Y, Wang Q, Yang J, Liu Y, Chen Y. Associations of retinal microvascular alterations with systemic diseases using optical coherence tomography angiography. BMC Ophthalmol. 2024;24:245.

8. Oto B, Kılıçarslan O, Kayadibi Y, Demirci H. Retinal microvascular changes in internal carotid artery stenosis detected using optical coherence tomography angiography. J Clin Med. 2023;12(18):6014.

9. Chua J, Chin CWL, Hong J, Chee ML, Wong TY. Impact of systemic cardiovascular disease on retinal microvascular architecture using optical coherence tomography angiography. J Clin Med. 2023;12(3):829.

10. Sabanayagam C, Cheung CY, Banu R, Cheng CY, Wong TY. Retinal microvascular biomarkers for cardiovascular disease risk prediction. Prog Cardiovasc Dis. 2022;70:6-15.

11. Al-Fiadh AH, Farouque O, Kawasaki R, Wong TY. Retinal microvascular parameters and coronary artery disease severity assessed by optical coherence tomography angiography. Acta Ophthalmol. 2021;99(7):e1117-e1124.

12. Cheung CY, Xu D, Cheng CY, Sabanayagam C, Wong TY. Retinal vascular imaging as a biomarker for systemic cardiovascular diseases. Prog Retin Eye Res. 2022;89:101036.

13. McGrory S, Ballerini L, Doubal FN, Valdés Hernández MC, MacGillivray TJ, Wardlaw JM. Retinal microvasculature and cardiovascular disease risk: A review. Hypertension. 2022;79(9):1789-1798.

14. Wang JJ, Liew G, Klein R, Mitchell P, Wong TY. Retinal vessel calibre and cardiovascular outcomes in population-based studies. Lancet Digit Health. 2022;4(2):e110-e119.

15. Chen KY, Chan HC, Chan CM. Association between retinal vein occlusion and myocardial infarction: A systematic review and meta-analysis. Int J Retina Vitreous. 2024;10:18.

16. Zhang W, Guo X, Han X. Retinal vascular abnormalities as predictors of coronary heart disease. Retina. 2024;44(4):712-720.

17. Rusu AC, Horvath KU, Bulgaru-Iliescu A, Tinica G. Retinal microvascular imaging as a biomarker in

coronary artery disease. Life (Basel). 2024;14(4):448.

18. Bayat K, Pooyan P, Chhablani J, Al-Qahtani A. Retinal and choroidal alterations in heart failure: A systematic review and meta-analysis. Ophthalmol Ther. 2025;14:345-358.

19. Haq ZU, Shah SA, Khan A, et al. Artificial intelligence-based retinal imaging for cardiovascular risk prediction. Front Cardiovasc Med. 2023;10:1132451.

20. Ong YT, Sabanayagam C, Cheung CY, Wong TY. Retinal vascular imaging in systemic disease screening. Nat Rev Cardiol. 2022;19(2):85-101.

21. Ballerini L, Trucco E, Doubal FN. Retinal vascular biomarkers for systemic cardiovascular disease detection. Front Med (Lausanne). 2023;10:1183024.