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Ocular Perfusion Pressure as a Predictive Biomarker for Glaucoma in Young Adults: A Cross-Sectional Study in Nigeria

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ABSTRACT

Background: Ocular perfusion pressure (OPP) has been suggested as a possible risk factor for the development of primary open-angle glaucoma (POAG). While OPP has been extensively studied in older populations, its role as a predictive biomarker in young adults remains underexplored, particularly in sub-Saharan Africa. This study investigated OPP as a predictive biomarker for glaucoma among young adults in Abia State University, Uturu, Nigeria.

Materials and Methods: A purposive cross-sectional study was conducted involving 100 young adults aged 18-35 years. OPP was calculated from mean arterial pressure (MAP) and intraocular pressure (IOP) measurements. Participants were classified into glaucoma status categories based on clinical examination. Data were analyzed using one-way ANOVA at $p<0.05$ significance level.

Results: Mean OPP differed significantly across glaucoma status categories ($F=3.81$, $p=0.026$). Glaucoma-positive participants had the lowest mean OPP (37.2 ± 6.8 mmHg), glaucoma suspects had intermediate values (42.3 ± 11.1 mmHg), and participants without glaucoma showed the highest mean OPP (44.6 ± 5.4 mmHg). MAP significantly predicted OPP ($\beta = 0.70$, $p < 0.001$).

Conclusion: Ocular perfusion pressure is significantly lower in individuals with glaucoma compared to those without glaucoma, even among young adults. These findings support OPP as a potential adjunctive biomarker in glaucoma risk assessment. Incorporating OPP into routine screening protocols may help identify young adults at higher risk of glaucomatous changes.

Keywords: Ocular Perfusion Pressure; Glaucoma; Biomarker; Young Adults; Primary Open-Angle Glaucoma; Nigerian Population.

I. Introduction

Glaucoma is among the most common causes of irreversible vision loss worldwide. Evidence from epidemiologic studies and clinical trials alike suggests that ocular perfusion pressure (OPP)-in simplest terms, the difference between intraocular pressure (IOP) and systemic blood pressure (BP)-as well as other factors such as blood pressure, vasospasm, and ischemia may all contribute to glaucoma risk[1]. Vascular factors have long been suspected of playing an important role in the glaucomatous process in addition to IOP. In this aspect, previous studies have reported a significant association between low OPP and glaucoma. Low OPP represents hypoperfusion to the optic nerve head, ultimately leading to the optic nerve head being deprived of nutrition and oxygenation[2]. Glaucoma is a progressive optic neuropathy of unknown origin. It has been hypothesized that a vascular component is involved in glaucoma pathophysiology. This hypothesis has gained support from studies showing that reduced OPP is a risk factor for the disease[3].

A fall in perfusion pressure at the optic disc may be caused by hypotension, vasospasm, or acute blood loss[4]. A low OPP can impair perfusion of the optic nerve head leading to glaucomatous cupping and visual field loss. As OPP encompasses both systemic BP and IOP, it could be used to evaluate the presence and evolution of open-angle glaucoma better. Understanding the relationship between IOP, systemic hypertension, and OPP can be helpful in assessing the risk factors for the development of open-angle glaucoma[4].

Primary Open Angle Glaucoma (POAG) typically manifests as slow, painless damage to the optic nerve due to an ineffective drainage system in the eye[5]. Patients with POAG often have elevated IOP readings correlating with characteristic optic nerve damage and visual field defect patterns[5]. Primary open-angle glaucoma is a multifactorial chronic optic neuropathy, characterized by progressive loss of retinal ganglion cells (RGC), leading to structural damage to the optic nerve head (ONH), retinal nerve fiber layer (RNFL), with visual field defects[6]. Risk factors for POAG include older age, African race or Latino/Hispanic ethnicity, elevated IOP, family history of glaucoma, lower OPP, type 2 diabetes mellitus, and thin central cornea[7].

Ocular perfusion pressure has been suggested as a possible risk factor for the development of primary open-angle glaucoma[8]. It is an essential factor in maintaining adequate blood flow to the optic nerve and retina. Many epidemiological studies have been done on OPP in relation with older adults. However, limited attention has been given to this study in relation to young adults. Hence the need for

this study, to understand the pattern and clinical implication of OPP amongst young adults in Abia State University, Uturu, which will help in early detection of persons who might be at risk of glaucoma.

II. Materials And Methods

Study Design and Population: This purposive cross-sectional study was carried out at the Optometry Clinic, Abia State University, Uturu, Nigeria, from November 2024 to February 2025. A total of 100 young adults aged 18-35 years were recruited.

Inclusion and Exclusion Criteria: Individuals aged 18-35 years who gave their consent were included in the study. Individuals outside the age bracket, individuals with known cardiovascular diseases, individuals on antihypertensive medications and individuals with ocular pathologies other than glaucoma were excluded from the study.

Procedure methodology

Blood pressure was measured using a sphygmomanometer according to standard protocol[9]. IOP was measured using Goldmann applanation tonometry[10]. Mean arterial pressure (MAP) was calculated as: MAP = Diastolic blood pressure (DBP) + 1/3 (Systolic blood pressure (SBP) – Diastolic blood pressure). OPP was calculated as: OPP = 2/3 [DBP + 1/3 (SBP – DBP)] – IOP.

Glaucoma Status Classification:

Participants were classified based on comprehensive clinical examination including IOP measurement, optic nerve head assessment using ophthalmoscopy, and visual field evaluation where indicated. Categories were: "No Glaucoma" (IOP <21 mmHg, no optic nerve changes); "Glaucoma Suspect" (IOP >21 mmHg, no definitive optic nerve damage); and "Glaucoma Positive" (IOP elevated with characteristic optic nerve changes and/or visual field defects).

Statistical analysis

Data obtained from this study were analyzed using SPSS version 21. One-way ANOVA was used to compare OPP across glaucoma status categories at 5% significance level.

Ethical consideration

Being a study involving humans, written consent of the individual involved was obtained before the commencement of the work. Ethical approval was obtained from the Research and Ethical committee of Abia State University, Uturu.

III. Results

Among 100 participants, 85 were classified as no glaucoma, 10 as glaucoma suspects, and 5 as glaucoma positive.

Mean OPP differed significantly across glaucoma status categories (F=3.81, p=0.026). Glaucoma-positive participants had the lowest mean OPP (37.2 ± 6.8 mmHg), glaucoma suspects had intermediate values (42.3 ± 11.1 mmHg), and participants without glaucoma showed the highest mean OPP (44.6 ± 5.4 mmHg) as shown in Table 1.

Table 1: Mean OPP by Glaucoma Status

Glaucoma Status	Frequency (n)	Mean OPP (mmHg)	SD	F-value	p-value
No	85	44.6	5.4	3.81	0.026
Suspect	10	42.3	11.1		
Yes	5	37.2	6.8		

Table 2 shows that mean arterial pressure significantly predicted OPP (β = 0.70, t = 18.10, p < 0.001).

Table 2: Linear Regression Analysis Predicting OPP

Predictor	β	t-value	p-value	95% CI (Lower)	95% CI (Upper)
Mean Arterial Pressure	0.70	18.10	<0.001	0.62	0.77

IV. Discussion

The ocular perfusion pressure (OPP) as a predictive biomarker for glaucoma was investigated among 100 young adults at Abia State University, Uturu, Nigeria. The mean age was 24.0 ± 4.7 years, with females constituting 55.0% and males 45.0%.

The findings show that mean OPP differs significantly across glaucoma status categories (F=3.81, p=0.026). Glaucoma-positive participants had the lowest mean OPP (37.2 ± 6.8 mmHg), glaucoma suspects had intermediate values (42.3 ± 11.1 mmHg), and those without glaucoma showed the highest mean OPP (44.6 ± 5.4 mmHg). This gradient suggests that reduced OPP is associated with the presence and severity of glaucoma, even in early adulthood.

These findings support the evidence that reduced OPP is associated with glaucoma and may serve as a useful vascular biomarker for glaucomatous risk. Kim *et al.*[2], in a meta-analysis, reported significantly lower OPP in patients with open-angle glaucoma compared with controls, suggesting that low OPP may contribute to optic nerve head ischemia and glaucomatous damage. Similarly, Liang *et al.*[11] demonstrated consistently lower systolic, diastolic, and mean OPP in patients with primary open-angle glaucoma compared with glaucoma suspects.

Evidence from African populations also aligns with the present findings. In Nigeria, Arinze *et al.*[8] reported significantly lower OPP in patients with primary open-angle glaucoma compared with non-glaucomatous individuals. The consistency of reduced OPP across diverse populations strengthens the argument that OPP may reflect underlying vascular compromise in glaucoma and thus function as a useful biomarker.

Gore *et al.*[12] (2019) reported that low OPP was strongly associated with an increased risk of POAG, with individuals having OPP less than 50 mmHg exhibiting substantially higher relative risk of glaucoma . This threshold-based association further supports the potential clinical utility of OPP as a risk stratification biomarker. In their study, lower OPP was strongly associated with an increased risk for POAG, with a relative risk of 6.27 and odds ratio of 0.075 for those with OPP less than 50 mmHg[12].

In Colombia, Cantor *et al.*[13] (2018) evaluated the relationship between blood pressure, OPP, and occurrence of POAG in 1,272 individuals. High values of diastolic BP (>90 mmHg) and low values of OPP (<40 mmHg) were associated with an increased risk of confirmed POAG. This aligns with the present finding that lower OPP is associated with glaucoma presence.

In Enugu, South East Nigeria, Arinze et al.[8] conducted a descriptive and comparative survey involving 120 subjects. The mean OPP was found to be significantly lower in the POAG subjects (Right eye, R=43.6 ± 12.6, left eye, L=41.9 ± 13.3 mmHg) compared with the non-glaucomatous group (R=53.9 ± 10.9, L=53.7 ± 10.9 mmHg) ($p<0.001$ for both eyes). The observed relationship suggests that reduced OPP may play a role in the development of POAG.

In contrast, some studies have reported more nuanced relationships between OPP and glaucoma. Tharn *et al.*[14] found that only low systolic OPP, but not mean or diastolic OPP, was independently associated with POAG after adjustment for IOP and confounders. This suggests that not all components of OPP may carry equal biomarker value.

Deb *et al.*[15] reported that individuals on antihypertensive medications were more likely to have glaucoma or be glaucoma suspects, and that higher OPP was relatively protective. These findings suggest that systemic vascular regulation and treatment-related BP fluctuations may confound the relationship between OPP and glaucomatous damage.

The significant difference in mean OPP across glaucoma status categories suggests that OPP may serve as a useful adjunctive marker in glaucoma risk assessment, even in younger populations. This has implications for early preventive strategies, as incorporating OPP into routine screening protocols

may help identify young adults who, despite having normal IOP, may have compromised OPP and therefore a higher risk of glaucomatous changes.

V. Conclusion

Results obtained in this study demonstrates that OPP is significantly lower in individuals with glaucoma compared to those without glaucoma, even among young adults. These findings support OPP as a potential adjunctive biomarker in glaucoma risk assessment; therefore, clinicians should incorporate OPP measurement into routine glaucoma risk assessment protocols. Also, baseline OPP documentation is recommended for young adults with family history of glaucoma.

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The author(s) declare that it is not applicable.

Consent for publication
The author(s) declare that this is not applicable.

Competing interests
The author(s) declare that they have no competing interests.

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