Original Article

Distribution of Ocular Perfusion Pressure and its Relationship with Intraocular Pressure in Patients with Primary Open Angle Glaucoma in Enugu, South East, Nigeria

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Abstract

Background: Ocular perfusion pressure (OPP) has been suggested as a possible risk factor for the development and progression of primary open angle glaucoma (POAG). **Aim:** To determine the distribution of OPP and its relationship with intraocular pressure (IOP) in Nigerian patients with POAG. **Patients and Methods**: A descriptive and comparative survey was adopted. A total of 120 subjects, 60 newly diagnosed POAG and 60 non-glaucomatous (NG) subjects, aged 40 years and above, who attended the ophthalmic clinic of University of Nigeria Teaching Hospital Enugu were recruited over a six-month period in 2019. All the subjects had ocular examination, blood pressure and IOP measurements. Statistical package for social sciences software version 25 was used for data analysis. Chi-square test, independent samples t-test, and Mann-Whitney U test were used for comparison while Pearson correlation and simple linear regression were used to ascertain the relationship. A *P* value of <0.05 was considered significant. **Result:** The mean age of the participants was 57.9 + 11.9 years. 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 NG group (R = 53.9 ± 10.9, L = 53.7 ± 10.9) mmHg ($p < 0.001$ for both eyes). A significant inverse relationship was observed between OPP and IOP in POAG subjects ($p < 0.001$), while there was none in NG subjects. **Conclusion:** OPP was lower in POAG subjects than in NG subjects. The observed relationship suggests that reduced OPP may play a role in the development of POAG.

Keywords: *Intraocular pressure, ocular perfusion pressure, primary open angle glaucoma*

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Introduction

Globally, glaucoma is the leading cause of avoidable, irreversible blindness, affecting about 64.3 million people, with a prevalence of 3.54% in those aged between 40 and 80 years.[1] The prevalence of primary open angle glaucoma (POAG) is highest in Africa (4.2%).[1] In Nigeria, it accounted for 16.7% of blindness and the leading cause of functional low vision.[2]

The mechanisms underlying the development and progression of glaucoma still remain uncertain.[3] Several risk factors have been implicated with intraocular pressure (IOP) being the only modifiable risk factor. Reducing IOP is effective in reducing the progression of the disease, however, progression still occurs in some cases despite adequate IOP control.[3] Vascular risk factors such as blood pressure (BP) and ocular perfusion pressure (OPP) have been implicated in the pathogenesis of glaucoma.[4] Several studies across the world have

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demonstrated the positive relationship between reduced OPP and increased prevalence and progression of POAG.[3-10] Racial variations exist in BP and IOP,[3] the distribution of OPP and its relationship with IOP in glaucoma patients might be different among Nigerians. There is paucity of data on OPP in Nigeria, especially in the South-East region, which harbors predominantly the ethnic Ibos with the greatest risk of glaucoma associated blindness.[11]

Hence the decision to conduct this survey aimed at generating comparative values of OPP in normal and glaucoma Nigerian subjects, as well as establishing the relationship between OPP and IOP in patients with POAG. Additionally, this study intends to establish the relevance or otherwise of OPP as a routine data in the management of POAG in Nigeria or elsewhere with similar setting.

Materials and Methods

Study area: The study was conducted at the University of Nigeria Teaching Hospital (UNTH) Ituku-Ozalla, Enugu. The hospital was established in 1960 and is located in the South-Eastern geo-political region of Nigeria. It functions as a referral centre in all aspects of medicine and surgery, for the entire South-East, South-South, North-Central, and other parts of Nigeria.

Study design: A descriptive and comparative analytical hospital-based survey was adopted. Sixty consecutive newly diagnosed POAG and 60 aged-matched non-glaucomatous (NG) subjects who attended the eye clinic of UNTH from January to July, 2019 and voluntarily gave their consent were recruited for the study.

Inclusion criteria: Newly diagnosed POAG patients aged 40 years and above attending the eye clinic of UNTH, Enugu who had not commenced anti-glaucoma medications and gave an informed consent were recruited for the study. Diagnosis of POAG was based on presence of open angles on gonioscopy as well as:

a. Vertical cup to disc ratio ≥0.6 or disc asymmetry >0.2.
b. Glaucomatous visual field loss observed on two or more central visual field analysis.

NG aged-matched patients (40 years and above) attending the eye clinic, who had refractive error or presbyopia and gave their consent were equally recruited for the study.

Exclusion criteria: Patients with co-existing ocular pathologies, systemic vascular diseases such as hypertension, diabetes mellitus, migraine or those on anti-glaucoma and/or anti-hypertensive medications were excluded.

Ethical clearance

Approval for the study was obtained from the Health Research and Ethics Committee (institutional review board) of the University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu, according to the tenets of the Helsinki Declaration as amended.

Informed consent

Written informed consent was obtained from each participant. Participation in the study was voluntary and at no cost to the patient, who also had the freedom to withdraw from the study at any time they deemed fit.

Sample size calculation

The minimum sample size was calculated using the formula below:[12]

$$N = \left\{ \frac{(Z\alpha/2 + Z\beta)^2}{C(r)^2} \right\} + 3$$

Where,

N = Minimum sample size of each of the study group.

α = Probability of making type one error.

B = Probability of making type two error.

$Z\alpha/2$ = Level of significance of type one error probability determined from a statistical table based on the value of level of significance α; for this study it was set at 0.05. The 95% confidence interval = 1.96 for a two-tailed test (standard normal deviate).

$Z\beta$ = This is type two error probability corresponding to standard normal deviate for a stated power of the study to detect a significant difference.

For this study, a power of 80% was used therefore $Z\beta$ = 0.84.

C (r) = correlation between OPP, IOP, and BP (r = 0.40).

$$N = \left\{ \frac{(1.96 + 0.84)^2}{C(0.40)^2} \right\} + 3$$

N = 52

Correcting for an attrition rate of 10% = 5.2.

Minimum sample size = 52 + 5.2 (attrition rate) = 57.2 ≈ 57.

57 for POAG patients and 57 for non-glaucomatous group.

The total minimum sample size was 114 which was approximated to 120 (60 newly diagnosed POAG and 60 NG subjects).

Sampling technique: To obtain the required sample size, consecutive enrolment was used. All consecutive, consenting patients who met the inclusion criteria were enrolled into the study until the estimated sample size was obtained for the two groups.

Study procedure: New patients diagnosed with POAG were evaluated for eligibility and recruited into the study, as well as the non-glaucoma patients. After obtaining consent, a pre-tested, structured questionnaire comprising of two sections: sociodemographic and clinical sections were administered by the researchers. Thereafter, each participant had the following examinations.

Blood pressure: Subjects were allowed to rest for at least 2 hours after arriving at the hospital to ensure a stable hemodynamic condition before measuring BP on the upper arm. BP was measured with an automated BP monitor (Dinamap model). The mean of two measurements taken in a sitting position at least 30 min apart with the appropriate cuff placed around the upper arm was recorded.

Intraocular pressure: This was measured using Goldman applanation tonometer. The prism was disinfected with isopropyl alcohol 70% rinsed in sterile water and wiped dry with a clean swab. After checking the graduation and setting the calibrated dial to 10 mmHg, the patient was seated comfortably at the slit-lamp, local anesthetic drops and fluorescein strip was instilled in the lower fornix of the conjunctiva, with the patient looking straight ahead, the prism was gradually placed to rest gently on the centre of the patient's cornea, the calibrated dial on the tonometer was turned clockwise until the inner edges of the semi-circles in the prism head were seen to touch. The reading on the dial was noted and recorded.

The mean OPP was calculated from the BP and IOP using this formula:

OPP = 2/3 of the mean arterial BP - IOP, where

Mean arterial pressure = Diastolic Blood Pressure (DBP) + 1/3{Systolic Blood Pressure (SBP) – DBP}.

Mean OPP was calculated for each group.

Data management: Statistical package for social sciences software version 25 was used for data analysis. The descriptive statistics – frequency, percentage, mean, range, and standard deviation were used to summarize the data. Chi-square test, independent samples t-test, and Mann-Whitney U test, one factor independent measures analysis of variance (ANOVA), and Kruskal-Wallis H test, were used for comparison of OPP values between POAG and non-glaucoma subjects while Pearson correlation and simple linear regression were used to ascertain the relationship OPP and IOP in the two study groups. A P value of < 0.05 was used to define statistical significance at 95% confidence interval.

Results

The participants comprised 77 females and 43 males with a mean age of 57.91 + 11.9 years. Comparison of the sociodemographic profile between the POAG and NG subjects revealed no statistically significant difference [Table 1].

OPP values in both eyes were higher in females than males in the NG group (RE: 54.36 ± 12.3 vs 53.05 ± 7.5; LE: 54.48 ± 12.4 vs 52.10 ± 6.8). Female OPP values were equally higher than those of their male counterparts in the POAG group [Table 2]. Those aged 70 years and above had the highest OPP (RE: 57.22 ± 11.4 and LE: 56.61 ± 10.2) among the NG group, and the least values (RE: 37.03 ± 10.1 and LE: 38.03 ± 11.1) in POAG subjects [Table 2].

Table 1: Sociodemographic characteristics of the subjects (n=120)

Variables	Subjects *n* (%)		Total	*P*
	NG	POAG		
Age (Years)				
40-49	14 (23.3)	21 (35.0)	35 (29.2)	0.504
50-59	18 (30.0)	18 (30.0)	36 (30.0)	
60-69	15 (25.0)	11 (18.3)	26 (30.0)	
70 years and above	13 (21.7)	10 (16.7)	23 (19.2)	
Total	60 (100.0)	60 (100.0)	120 (100.0)	
Mean Age	59.17+11.8	56.68+12.1	57.91+11.9	0.258
Sex				
Female	41 (68.3)	36 (60.0)	77 (64.2)	0.341
Male	19 (31.7)	24 (40.0)	43 (35.8)	
Total	60 (100.0)	60 (100.0)	120 (100.0)	
Occupation				
Artisans	7 (11.7)	12 (20.0)	19 (15.8)	0.796
Civil servants	12 (20.0)	12 (20.0)	24 (20.0)	
Farmers	13 (21.7)	11 (18.3)	24 (20.0)	
Retirees	6 (10.0)	5 (8.3)	11 (9.2)	
Traders	22 (36.7)	20 (33.3)	42 (35.0)	
Total	60 (100.0)	60 (100.0)	120 (100.0)	
Educational Status				
Primary	8 (13.3)	12 (20.0)	20 (16.7)	0.503
Secondary	40 (66.7)	38 (63.3)	78 (65.0)	
Tertiary	8 (13.3)	6 (10.0)	14 (11.7)	
None	4 (6.7)	4 (6.7)	8 (6.6)	
Total	60 (100.0)	60 (100.0)	120 (100.0)	

Table 2: Distribution of OPP by age and sex among the subjects (*n*=120)

	Mean OPP (NG)		Mean OPP (POAG)	
	RE	LE	RE	LE
Age (years)				
40-49	52.44±14.3	52.44±15.0	45.75±16.5	43.56±18.3
50-59	55.07±10.5	54.46±11.1	43.19±9.1	40.97±8.5
60-69	51.14±7.0	51.54±6.5	46.48±10.3	44.21±10.5
70+	57.22±11.4	56.61±10.2	37.03±10.1	38.03±11.1
Sex				
Male	53.05±7.5	52.10±6.8	42.88±12.8	41.34±15.1
Female	54.36±12.3	54.48±12.4	44.19±12.7	42.41±12.1

Table 3: Comparison of OPP between the NG and POAG subjects

OPP	Subjects	*n*	Mean	S. D	*t*	*P*
Right	NG	60	53.94	10.99	4.745	0.001*
	POAG	60	43.66	12.67		
Left	NG	60	53.72	10.96	5.278	0.001*
	POAG	60	41.97	13.30		

Table 4: Relationship between OPP and IOP in the NG and POAG subjects

	OPP RE				OPP LE			
	R	Constant	B	*P*	*r*	Constant	B	*P*
NG								
IOP	0.02	52.556	0.090	0.85	0.041	51.273	0.156	0.754
POAG								
IOP	-0.30	64.882	-0.856	0.03*	-0.40	67.362	-0.958	0.002*

OPP values in both eyes among the POAG subjects were significantly lower ($p < 0.001$) compared with those in the NG group (RE: 43.66 ± 12.67 vs 53.94 ± 10.99; LE: 41.97 ± 13.30 vs 53.72 ± 10.96) [Table 3].

A significant inverse relationship was observed between OPP and IOP in both eyes in the POAG group (RE: $P = 0.03$; LE: $P = 0.002$) while there was none in the NG subjects [Table 4].

Discussion

In this study, OPP was found to be significantly lower among the POAG subjects compared with the NG group. This finding is similar to those reported in several previous studies in different countries,[3-10,13,14] which showed that OPP values were lower among the POAG compared to their NG counterparts. Conversely, our result is not in agreement with that reported from a previous study in China,[15] which found no significant reduction in OPP among the POAG subjects. This difference could be due to racial factors as Asians have been known to have lower BP values compared to blacks and Caucasians. The significant inverse relationship observed between OPP and IOP in the POAG group supports the role of vascular factors in the aetiology of POAG. Poor perfusion of the optic nerve head, consequent upon impaired vascular autoregulation,[16,17] and altered blood flow in the optic disc increases the risk of POAG.[18,19] OPP is affected either by a low BP, high IOP, treatment to lower BP or IOP, or a combination of these variables. It is therefore, pertinent for OPP to be routinely assessed in glaucoma, more importantly, in hypertensive glaucoma patients. Therefore, a multi-disciplinary approach by the Ophthalmologists and the internal medicine Physicians should be deployed in the management of these patients. This will help in halting the progressive loss of the optic nerve fibres.

Conclusion

The findings from the present study showed that OPP is inversely related to IOP and suggest that reduced OPP may play a role in the development of POAG in the Nigerian subjects. Routine assessment of OPP and co-management of glaucoma patients with the Physicians especially those with progression despite adequate IOP control is therefore, recommended.

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Conflicts of interest

There are no conflicts of interest.

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