ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

Investigating the prevalence of primary open-angle glaucoma among patients with systemic hypertension: A cross-sectional study

Gudla Vasantha[1], Mounica Kakuturu[2], Bandari Teja Sri[3]

[1]Associate Professor, [2,3]Senior Resident, Department of Ophthalmology, Government Medical College, Jangaon, Telangana, India

Submission: 01-11-2023 Revision: 30-11-2023 Publication: 01-01-2024

ABSTRACT

Background: Primary open-angle glaucoma (POAG) is a significant cause of irreversible blindness worldwide. **Aims and Objectives:** This study aimed to investigate the prevalence of POAG among hypertensive patients. **Materials and Methods:** A comprehensive analysis was conducted on 200 hypertensive patients, categorizing them by gender, age groups, and blood pressure ranges. POAG was diagnosed using standardized criteria, and mean intraocular pressure (IOP) values were compared between POAG patients and normal individuals. The study also assessed the change in IOP across various ranges of systolic and diastolic blood pressure (SBP and DBP). **Results:** Among the hypertensive population, 5% of males and 3% of females were diagnosed with POAG, indicating a slightly higher prevalence in males. POAG incidence was notably higher in the 60–69 years of age group, suggesting a potential correlation with older age. Analysis of mean IOP values demonstrated significantly higher readings in both eyes of POAG patients compared to normal individuals, aligning with the hallmark of glaucoma. The distribution of hypertensive patients across different SBP and DBP ranges revealed that higher SBP levels (140–149 mmHg and ≥160 mmHg) were associated with more POAG cases. Similarly, elevated DBP levels (90–99 mmHg) showed the highest number of POAG cases. **Conclusion:** Our study suggests a slightly higher prevalence of POAG in male hypertensive patients and highlights older age as a potential risk factor. Elevated IOP, a characteristic feature of glaucoma, was confirmed in POAG patients. In addition, our findings indicate a potential association between higher SBP and DBP levels and an increased likelihood of POAG, emphasizing the importance of blood pressure management in glaucoma care.

Key words: Primary open-angle glaucoma; Systemic hypertension; Intraocular pressure; Blood pressure levels

Access this article online

Website: http://nepjol.info/index.php/AJMS

DOI: 10.3126/ajms.v15i1.59599

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

Primary open-angle glaucoma (POAG) is a chronic, progressive optic neuropathy characterized by the slow and insidious loss of retinal ganglion cells, resulting in characteristic optic nerve head changes and corresponding visual field defects.[1] It is a leading cause of irreversible blindness worldwide, and its prevalence is expected to rise significantly due to the aging global population. POAG is often associated with elevated intraocular pressure (IOP), which is considered a major risk factor for its development and progression.[2] However, the pathophysiology of POAG is complex, and multiple factors, including genetic, vascular, and mechanical, contribute to its onset and progression.

Hypertension, a common cardiovascular condition, has long been suggested as a potential risk factor for POAG. The relationship between systemic hypertension and glaucoma has been the subject of extensive investigation, but the results have often been conflicting.[3] Some studies have reported a significant association between hypertension and POAG, while others have found no such link. These

Address for Correspondence:
Dr. Mounica Kakuturu, Senior Resident, Department of Ophthalmology, Government Medical College, Jangaon, Telangana, India.
Mobile: +91-9494262999. **E-mail:** mounicakakuturu44@gmail.com

discrepancies may be attributed to the heterogeneity of study populations, variations in diagnostic criteria, and differences in study designs.[4,5]

Hypertension is characterized by elevated blood pressure levels, and it can lead to significant changes in the cardiovascular system.[6] Chronic hypertension can cause vascular remodeling, leading to increased vascular resistance and altered autoregulation of blood flow. These changes may affect ocular blood flow and, subsequently, optic nerve head perfusion, which is crucial for the maintenance of retinal ganglion cell viability.[7] Furthermore, hypertension can influence the biomechanics of the optic nerve head, making it more susceptible to damage from elevated IOP.

Many broad epidemiological studies have endeavored to understand the connection between systemic hypertension and POAG. Their outcomes have varied: while some indicate a potential relationship, others do not see any discernible connection. For instance, the Rotterdam Study suggested a link between high blood pressure and POAG, but such a correlation was not found in the Barbados eye study. Likewise, the Blue Mountains Eye Study noted a greater likelihood of glaucoma with increased systolic blood pressure (SBP), but this observation was not corroborated by the Egna-Neumarkt study.

In light of the varied outcomes from past studies, there is a pressing need for deeper exploration into the connection between hypertension and POAG, particularly within certain demographics. With this perspective, our current study seeks to augment the existing literature by examining the frequency of POAG in hypertensive individuals within our community. We intend to evaluate numerous elements such as gender, age, IOP, and blood pressure metrics to attain a holistic insight into the intricate nexus between hypertension and POAG.

Aim and objectives

The primary aim of this research is to investigate the occurrence of POAG among hypertensive individuals. To accomplish this aim, we have set the following objectives:

- To determine the prevalence of POAG in a population of hypertensive patients.
- To assess whether there is a gender-based difference in the prevalence of POAG among hypertensive individuals.
- To examine the distribution of POAG cases across different age groups within the hypertensive population.
- To compare mean IOP values between POAG patients and normal individuals.
- To analyze the relationship between SBP and diastolic blood pressure (DBP) levels and the occurrence of POAG in hypertensive patients.
- To assess the change in IOP over various ranges of SBP and DBP among hypertensive individuals.

MATERIALS AND METHODS

Study design and duration

This research was structured as an 18-month cross-sectional, observational study rooted in a hospital setting. Study Location The investigation took place at the Sarojini Devi Eye Hospital, a recognized affiliate of the Regional Institute of Ophthalmology, Hyderabad, Telangana.

Study setting and participants

The primary cohort for this study was drawn from 200 hypertensive patients who sought care at the Sarojini Devi Eye Hospital's Outpatient Department (OPD).

Sample size calculation

The sample size was determined based on the expected prevalence of POAG in hypertensive patients, with an acceptable margin of error and a confidence interval of 95%. Using a previously reported prevalence and employing the formula for calculating the sample size in epidemiological studies, we arrived at a sample size of 200.

Inclusion criteria

- Confirmed cases of systemic hypertension.
- Individuals aged 40 years and above.

Exclusion criteria

- Patients under 40 years.
- Diagnosed cases of secondary glaucoma.
- Presence of comorbidities such as diabetes mellitus or ischemic heart disease.
- Individuals exhibiting corneal abnormalities, such as scarring or opacity, making gonioscopy unfeasible.
- Patients with a history of ocular trauma or ocular diseases, with the exception of POAG.
- Those not willing to participate.

Study procedure

From the attendees at Sarojini Devi Eye Hospital's OPD, we identified 200 hypertensive individuals who met our criteria. Post briefing and securing informed consent, these participants underwent extensive ocular and systemic evaluations as outlined in the data acquisition segment.

Data acquisition and procedures

Demographics

Initial patient information was systematically collated.

Clinical assessment

Comprehensive reviews captured primary complaints, systemic ailment history, previous ocular surgeries, and familial glaucoma history.

Visual acuity

The Snellen's chart facilitated standardized evaluations.

Ophthalmic examination

Anterior segment assessments employed slit lamp biomicroscopy. IOP was ascertained using the Goldmann Applanation Tonometer and supplemented by gonioscopy through the Sussman 4 Mirror Gonio lens. In the presence of open angles, a post-dilation examination was performed using a slit lamp bolstered by a 90D lens.

Supplementary examinations

As clinically warranted, we initiated the Humphreys visual field analysis.

Systemic evaluation

Employing a sphygmomanometer, blood pressure readings were captured with participants seated. Preliminary investigations included blood pressure and fasting blood sugar metrics.

Ethical approval

The study was approved by the Institutional Ethics Committee, Osmania Medical College, Hyderabad, Telangana. A transparent briefing on study objectives and procedures preceded the acquisition of written consent from all participants.

Statistical analysis

Data from the study were entered into Microsoft Excel for organization and initial preparation. Subsequently, statistical analysis was performed using the Statistical Package for Social Sciences version 22. Descriptive statistics, such as means, standard deviations, frequencies, and percentages, were computed to summarize the demographic and clinical characteristics of the study population. The prevalence of POAG among hypertensive patients was calculated with corresponding confidence intervals. Comparative analyses, including Chi-square tests or t-tests where applicable, were conducted to assess the association between systemic hypertension and POAG, taking into account relevant covariates. A $P<0.05$ was considered statistically significant.

RESULTS

In the results section, we present a comprehensive analysis of POAG prevalence among hypertensive patients, considering various factors such as gender, age, IOP, and blood pressure levels. These findings offer critical insights into the intricate interplay between hypertension and POAG, shedding light on potential risk factors and associations within this patient population.

Sex-wise distribution of POAG in hypertensive patients

In this study, we observed a slight gender-based difference in the prevalence of POAG among hypertensive patients. Among the 100 male hypertensive patients, 5% were diagnosed with POAG, while among the 100 female hypertensive patients, 3% had POAG. This data suggests that within the studied hypertensive population, males exhibited a somewhat higher prevalence of POAG compared to females (Table 1) and (Figures 1 and 2).

Age distribution of hypertensives in the study group

Our findings reveal that the incidence of POAG in hypertensive patients was notably higher in the 60–69 years of age group, with 4 out of 8 POAG cases falling within this category. This underscores the potential correlation between older age and the risk of developing POAG among individuals with hypertension (Table 2) and (Figure 3).

Comparison of mean IOP among POAG patients and normal people

In this, we compared the mean IOP between POAG patients and normal individuals. The data clearly illustrate significantly higher mean IOP values in both the right and left eyes of POAG patients when compared to normal individuals. Elevated IOP is a hallmark of glaucoma, and these results highlight this characteristic difference between the two groups (Table 3) and (Figure 4).

Various ranges of SBP in the study group

Our study analyzed the distribution of hypertensive patients across different ranges of SBP and observed the corresponding number of POAG cases in each SBP category. The majority of POAG cases were concentrated

Table 1: Sex-wise distribution of POAG in hypertensive patients

Sex	Total no. of Patients	POAG	Percentage
Male	100	5	5
Female	100	3	3

POAG: Primary open-angle glaucoma

Table 2: Age distribution of hypertensives in the study group

Age group	Total No. of Patients	No. of patients with POAG
40–49	34	1
50–59	60	1
60–69	79	4
70–79	27	2

POAG: Primary open-angle glaucoma

in the SBP range of 140–149 mmHg, followed by the SBP range of ≥160 mmHg. These findings suggest a potential relationship between higher SBP levels and an increased likelihood of POAG (Table 4).

Change in IOP over various ranges of SBP

This data provides valuable insights into the relationship between SBP and IOP among hypertensive patients. As SBP increases, there is a corresponding increase in the percentage of patients with raised IOP. These results imply a potential association between elevated SBP and heightened IOP, a crucial consideration in the context of glaucoma management (Table 5).

Various ranges of DBP in the study group

Our study also examined the distribution of hypertensive patients across different ranges of DBP and noted the number of POAG cases in each DBP category. Notably, the highest number of POAG cases was observed in the DBP range of 90–99 mmHg, suggesting a potential link between DBP levels and the occurrence of POAG (Table 6).

Table 3: Comparison of mean intraocular pressure among POAG patients and normal people

Eye	POAG	Normal people
	Mean±SD (mm Hg)	Mean±SD (mm Hg)
Right Eye	21.50 Range: 16–24	14.55 Range: 10–20
Left Eye	22.75 Range: 16–28	14.56 Range: 10–20

POAG: Primary open-angle glaucoma, SD: Standard deviation

Table 4: Various ranges of SBP in the study group

SBP in mmHg	Total number	POAG
<140	24	0
140–149	65	4
150–159	78	2
≥160	33	2

POAG: Primary open-angle glaucoma, SBP: Systolic blood pressure

Table 5: Change in IOP over various ranges of SBP

SBP in mmHg	Total number	Patients with Raised IOP	IOP in mm Hg
		Number	%
<140	24	0	0
140–149	65	2	3.07
150–159	78	2	2.56
≥160	33	1	3.33

IOP: Intraocular pressure, SBP: Systolic blood pressure

Change in IOP over various ranges of DBP

Similarly, these data investigates the relationship between DBP and IOP among hypertensive patients. It reveals that as DBP rises, the percentage of patients with raised IOP also increases. This reinforces the potential influence of blood pressure, specifically DBP, on IOP levels (Table 7).

DISCUSSION

In our study involving 200 hypertensive patients, we aimed to investigate the prevalence of POAG in this specific patient population. Our findings revealed that out of the 200 patients, 8 individuals were diagnosed with POAG, resulting in a prevalence rate of 4%. These results are consistent with previous research studies, including the Latino Eye Study, West Bengal Eye Survey, Chennai Glaucoma Study, Aravind Comprehensive Eye Survey, as well as studies conducted by Ganagi et al.,[8] Garg et al.,[9] and Kuang et al.,[10] which have consistently reported a higher prevalence of POAG among older individuals.

The mean age of the patients diagnosed with POAG in our study was 64 years, with a notable trend indicating an increasing occurrence of POAG with advancing age. Specifically, 25% of POAG patients were below the age of 60 years, while 75% were above the age of 60. This observation reaffirms the well-established understanding that age is a significant risk factor for the development of POAG (Vijaya et al.,[11] Ramakrishnan et al.,[12] Mitchell et al.,[13] Omoti et al.[14])

One interesting aspect that emerged from our study was the gender-based discrepancy in the occurrence

Table 6: Various ranges of DBP in the study group

DBP in mmHg	Total number	POAG
70–79	24	1
80–89	65	2
90–99	78	4
≥100	33	1

POAG: Primary open-angle glaucoma, DBP: Diastolic blood pressure

Table 7: Change in IOP over various ranges of DBP

DBP in mmHg	Total number	Patients with raised IOP	IOP in mm Hg
		Number	%
70–79	5	0	0
80–89	45	0	0
90–99	146	4	2.73
≥100	4	1	0.25

IOP: Intraocular pressure, DBP: Diastolic blood pressure

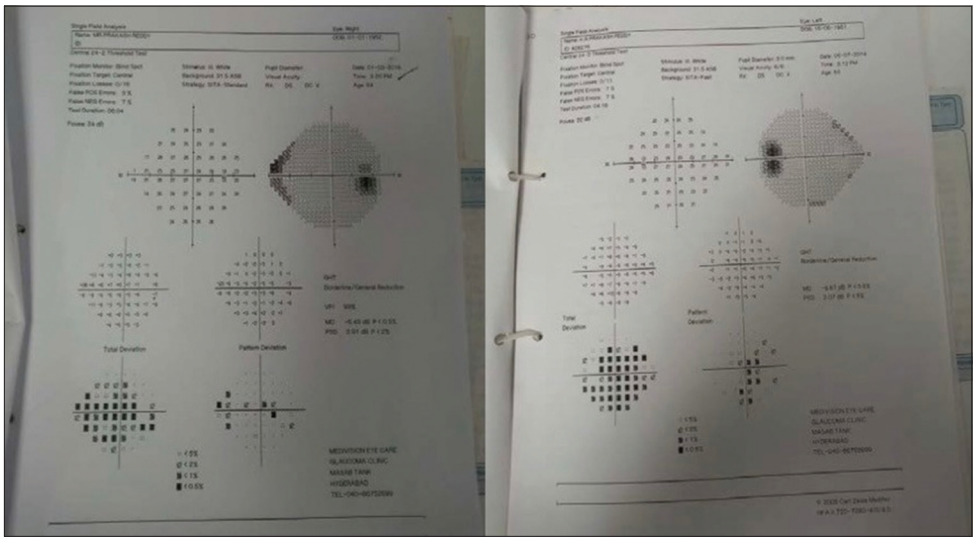

Figure 1: Binocular Esterman visual field (BE HVF 24-2) Results–right eye displays an early nasal step, while the left eye presents with a paracentral scotoma

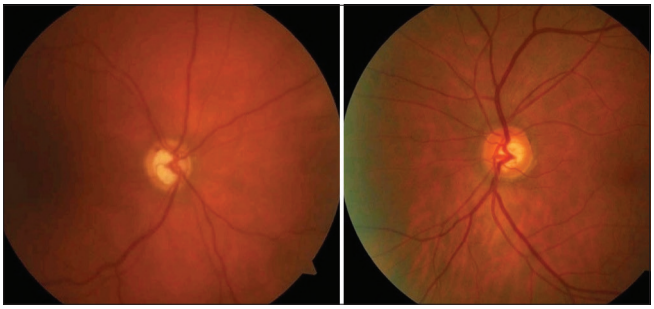

Figure 2: Ophthalmic examination findings–right eye: Clear media, medium-sized optic disc (OD) with 0.5:1 cup-to-disc ratio (CDR) and inferior rim thinning, healthy macula; left eye: Clear media, medium-sized OD with 0.6:1 CDR, horizontal notching of the retinal rim, healthy macula

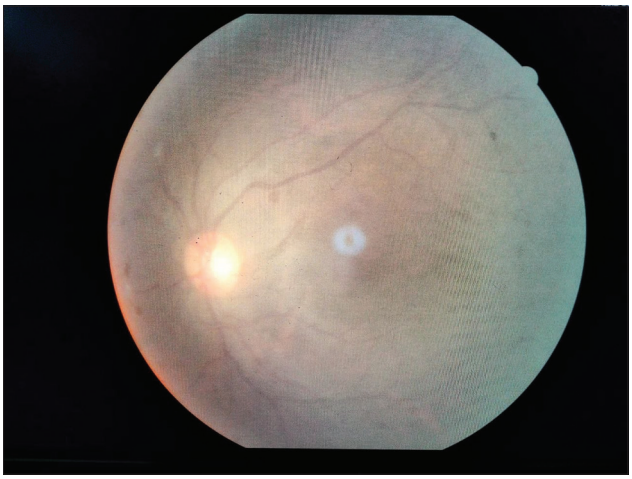

Figure 3: Left eye fundus examination-media obscured by lens opacification, medium-sized optic disc with 0.4:1 cup-to-disc ratio, horizontal notching of the retinal rim, normal vessels, and healthy macula

Figure 4: Optic disc examination revealing 0.8:1 cup-to-disc ratio with inferior and superior disc thinning; macular hemorrhage noted

of POAG. We found that 5 males and 3 females were diagnosed with POAG. This finding contrasts with some previous research, such as studies by Vijaya et al., and Venkatraman et al., which found no gender differences in POAG prevalence. However, it is consistent with other investigations such as those by Ramakrishnan et al., and Leske et al., which reported a higher prevalence of POAG in males. Conversely, the Blue Mountain Eye Study and Andhra Pradesh Eye Study reported a higher prevalence of POAG in females (Vijaya et al.,[11] Ramakrishnan et al.,[12] Mitchell et al.,[13] Omoti et al.[14])

Moreover, our study suggested a potential correlation between the duration of hypertension and the onset of glaucoma. Intriguingly, individuals in our research with POAG often had a track record of hypertension lasting between 5 and 10 years. This trend hints that the duration of hypertension might influence the development of glaucoma, perhaps because of changes in autoregulation

and the progression of arteriosclerosis in those with long-standing hypertension.

The link between systemic hypertension and POAG has been extensively researched across the globe, but findings have varied. Research initiatives such as the Egna-Neumarkt, Rotterdam, and Blue Mountain eye studies found notable connections between systemic blood pressure and POAG.[3,4] Conversely, other investigations, such as the Barbados eye study, early manifest glaucoma trial, and Latino eye study, did not observe this relationship. In line with some of these findings, our research also did not identify a significant link between the prevalence of POAG and systemic hypertension. Such differences in results might be due to ethnic variations and the complex pathophysiological processes underpinning POAG's onset (referencing Leske et al.,[15] Vijaya et al.,[11] and He et al.[16])

Limitations of the study

This study has several limitations that should be considered when interpreting the findings. The relatively small sample size of 200 hypertensive patients restricts the generalizability of the results. Being a single-center study, its external validity may be limited, and multicentre investigations are warranted. The cross-sectional design offers a snapshot but lacks the depth of longitudinal research. Selection bias may be present as the study was conducted in a tertiary care center, possibly overestimating POAG prevalence. Limited exploration of confounding variables and reliance on retrospective data are additional limitations. Generalizability to diverse populations and potential unaccounted confounders should be approached with caution.

CONCLUSION

This study provides critical insights into the intricate relationship between hypertension and POAG. It suggests a slightly higher prevalence of POAG in male hypertensive patients and highlights older age as a potential risk factor. Elevated IOP, a characteristic feature of glaucoma, was confirmed in POAG patients. In addition, our findings indicate a potential association between higher SBP and DBP levels and an increased likelihood of POAG, emphasizing the importance of blood pressure management in glaucoma care. Further research is warranted to explore these relationships comprehensively and inform clinical strategies for hypertensive patients at risk of POAG.

ACKNOWLEDGMENTS

The authors extend their gratitude to the staff of the Department of Ophthalmology, Osmania Medical College/Sarojini Devi Eye Hospital, Hyderabad, Telangana, India, for their invaluable assistance in this postgraduate dissertation work.

REFERENCES

1. Al-Manjoumi AM, Filimban MA, Bantan MS, Abualhamayel HA and Youldash OA. Prevalence of risk factors among patients with glaucoma in Jeddah, Saudi Arabia. Cureus. 2023;15(4):e37689. https://doi.org/10.7759/cureus.37689
2. Singh W, Salaria NS, Pandey ML, Bhandari V, Singh S and Bhardwaj P. Prevalence and associated risk factors of primary open angle glaucoma among patients with type 2 diabetes mellitus: A cross-sectional study from North India. Cureus. 2022;14(9):e28908. https://doi.org/10.7759/cureus.28908
3. Bonomi L, Marchini G, Marraffa M, Bernardi P, Morbio R and Varotto A. Vascular risk factors for primary open angle glaucoma: The Egna-Neumarkt study. Ophthalmology. 2000;107(7):1287-1293. https://doi.org/10.1016/s0161-6420(00)00138-x
4. Mitchell P, Hourihan F, Sandbach J and Wang JJ. The relationship between glaucoma and myopia: The Blue Mountains Eye study. Ophthalmology. 1999;106(10):2010-2015. https://doi.org/10.1016/s0161-6420(99)90416-5
5. Wolfs RC, Klaver CC, Ramrattan RS, van Duijn CM, Hofman A and de Jong PT. Genetic risk of primary open-angle glaucoma. Population-based familial aggregation study. Arch Ophthalmol. 1998;116(12):1640-1645. https://doi.org/10.1001/archopht.116.12.1640
6. Vijaya L, George R, Paul PG, Baskaran M, Arvind H, Raju P, et al. Prevalence of open-angle glaucoma in a rural south Indian population. Invest Ophthalmol Vis Sci. 2005;46(12):4461-4467. https://doi.org/10.1167/iovs.04-1529
7. Vegini F, Filho NF, Lenci RF, Neto DG and Susanna Junior R. Prevalence of open angle glaucoma in accompanying first degree relatives of patients with glaucoma. Clinics (Sao Paulo). 2008;63(3):329-332. https://doi.org/10.1590/s1807-59322008000300007
8. Ganagi SM, Gonsalves SR and Nazareth N. A study on primary open angle glaucoma in systemic hypertensives in patients in a tertiary care centre. Indian J Clin Exp Ophthalmol. 2019;5(2):155-158. https://doi.org/10.18231/j.ijceo.2019.038
9. Garg P, Malik M, Rai N, Singh A and Chellaiyan VG. Prevalence of pre-perimetric primary open angle glaucoma in hypertensives of North India. J Family Med Prim Care. 2022;11(9):5257-5262. https://doi.org/10.4103/jfmpc.jfmpc_2288_21
10. Kuang TM, Xirasagar S, Kao YW, Shia BC and Lin HC. Association of systemic hypertension with primary open-angle glaucoma: A population-based case-control study. Am J Ophthalmol. 2020;218:99-104. https://doi.org/10.1016/j.ajo.2020.04.020
11. Vijaya L, George R, Baskaran M, Arvind H, Raju P, Ramesh SV, et al. Prevalence of primary open-angle glaucoma in an urban south Indian population and comparison with a rural population. The Chennai Glaucoma Study. Ophthalmology. 2008;115(4):648-654.e1. https://doi.org/10.1016/j.ophtha.2007.04.062
12. Ramakrishnan R, Nirmalan PK, Krishnadas R, Thulasiraj RD, Tielsch JM, Katz J, et al. Glaucoma in a rural population of

Southern India: The Aravind comprehensive eye survey. Ophthalmology. 2003;110(8):1484-1490.
https://doi.org/10.1016/S0161-6420(03)00564-5

13. Mitchell P, Lee AJ, Rochtchina E and Wang JJ. Open-angle glaucoma and systemic hypertension: The blue mountains eye study. J Glaucoma. 2004;13(4):319-326.
https://doi.org/10.1097/00061198-200408000-00010
14. Omoti AE, Enock ME, Okeigbemen VW, Akpe BA and Fuh UC. Vascular risk factors for open angle glaucoma in African eyes. Middle East Afr J Ophthalmol. 2009;16(3):146-150.
https://doi.org/10.4103/0974-9233.56229
15. Leske MC, Wu SY, Nemesure B and Hennis A. Incident open-angle glaucoma and blood pressure. Arch Ophthalmol. 2002;120(7):954-959.
https://doi.org/10.1001/archopht.120.7.954
16. He J, Zou H, Lee RK, Tong X, Tang W, Zhang Y, et al. Prevalence and risk factors of primary open-angle glaucoma in a city of Eastern China: A population-based study in Pudong New district, Shanghai. BMC Ophthalmol. 2015;15:134.
https://doi.org/10.1186/s12886-015-0124-x

Authors Contribution:
GV- Concept and design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript; **MK-** Concept and design of the study, review of literature, and revision of manuscript and preparing first draft of manuscript; **BTS-** Design of the study review of literature and revision of manuscript and preparing first draft of manuscript.

Work attributed to:
Osmania Medical College/Sarojini Devi Eye Hospital, Hyderabad, Telangana, India.

Orcid ID:
Gudla Vasantha - https://orcid.org/0009-0008-8148-150X
Mounica Kakuturu - https://orcid.org/0009-0003-1839-6701
Bandari Teja Sri - https://orcid.org/0009-0004-5567-5491

Source of Support: Nil, **Conflicts of Interest:** None declared.