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Original Research Article

A Prospective Study to Correlate the Changes between Retinal Nerve Fiber Layer Thickness and Cupping of Disc Using Optical Coherence Tomography and Visual Field Changes Using Perimetry in Primary Open Angle Glaucoma Patients

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Abstract:

Introduction: Glaucoma, a leading cause of global irreversible blindness, includes Primary Open Angle Glaucoma (POAG), characterized by optic nerve damage and visual field loss. This study aims to correlate RNFL thickness, disc cupping, and visual field changes to enhance early glaucoma detection and management.

Objective: To investigate correlations between RNFL thickness, disc cupping, and visual field changes in primary open-angle glaucoma.

Methods: A cohort of 40 POAG patients was analysed. RNFLT was measured using OCT, while optic disc cupping was quantified through the vertical cup-to-disc ratio (VCDR). Perimetry was performed to assess visual field changes. Statistical analyses were conducted to determine correlations between variables.

Results: Out of40 POAG patients, mean right eye RNFL thickness was 79.98 µm (SD = 11.548 µm) and left eye RNFL thickness was 79.15 µm (SD = 13.917 µm). Mean right eye VCDR was 0.735 (SD = 0.1027), and left eye VCDR was 0.747 (SD = 0.0784). Strong correlations were observed between RNFLT and VCDR in both eyes ($p<0.05$). IOP and VCDR also showed associations, with higher IOP values linked to larger VCDR values ($p<0.05$). Perimetric analysis revealed prevalent early defects. Significant correlations were found between perimetric changes and both RNFLT and VCDR in both eyes ($p<0.05$).

Conclusions: This study establishes significant correlations between RNFLT, optic disc cupping, and visual field changes in primary open-angle glaucoma, underscoring their clinical relevance and potential for improved management.

Keywords: Primary Open Angle Glaucoma (POAG), RNFL thickness, vertical cup-to-disc ratio, Visual field changes.

Introduction

Glaucoma, a chronic and progressive optic neuropathy, is the leading cause of irreversible blindness worldwide. According to the World Health Organization, glaucoma accounts for approximately 13.5% of global blindness, affecting an estimated 60 million people worldwide. [1] Primary Open Angle Glaucoma (POAG) is the most prevalent subtype, responsible for about three-fourths of all glaucoma cases.

Characterized by elevated intraocular pressure (IOP), glaucomatous optic nerve damage, an open anterior chamber angle, and characteristic visual field loss, POAG is typically a bilateral disease of adult onset. [2]Various risk factors, such as age above 40 years, heredity, myopia, and diabetes mellitus, contribute to the pathogenesis of POAG. Early detection and proper treatment are crucial to prevent blindness, as there is currently no known treatment to restore lost vision once glaucoma has caused blindness. Detection relies on recognizing early clinical manifestations, including characteristic cupping of the optic disc with corresponding visual field defects due to retinal ganglion cell loss. [3,4]

Evaluation of the retinal nerve fibre layer (RNFL) and optic nerve head is essential for diagnosing and monitoring glaucoma. Spectral-domain optical coherence tomography (OCT) has proven effective in discriminating healthy eyes from those with glaucomatous visual field loss, aiding in glaucoma detection and monitoring by identifying subtle RNFL changes. [5,6]

The purpose of this prospective study is to correlate changes between RNFL thickness and cupping of the disc using OCT, along with visual field changes using perimetry, in patients with primary open-angle glaucoma. By evaluating these changes longitudinally, the study aims to facilitate early detection and monitoring of glaucomatous damage, potentially reducing the incidence of blindness caused by glaucoma. In summary, this study endeavours to enhance our understanding of glaucoma progression and provide valuable insights into its early detection and management, ultimately contributing to better patient outcomes and improved quality of life for those affected by this sight-threatening condition.

Methods

This study is a prospective, hospital-based investigation conducted in the Department of Ophthalmology at Sir T Hospital and Government Medical College, Bhavnagar, Gujarat. The objective is to correlate changes in retinal nerve fiber layer thickness (RNFLT) and cupping of the optic disc, assessed through Optical Coherence Tomography (OCT), with visual field changes measured using perimetry in patients diagnosed with Primary Open Angle Glaucoma (POAG). The study includes 40 adult patients aged between 20 to 60 years, who have a confirmed diagnosis of POAG and provided written informed consent. The research was carried out over a 12-month period, with no known risks involved for the participants.

Ethical considerations were carefully observed, with informed written consent obtained from each participant, ensuring confidentiality throughout the study and analysis stages, as well as during the publication of results. Exclusion criteria were established, such as patients with angle-closure glaucoma, secondary glaucoma, or other diseases affecting visual fields, and those on medications or with conditions that could influence the study outcomes.

The methodology involved a comprehensive eye examination for each patient, including adnexa and extraocular structures assessment, anterior segment evaluation, measurement of visual acuity and intraocular pressure, gonioscopy, visual field examination, and examination of the posterior segment. Additionally, OCT was used to assess the RNFLT and cupping of the optic disc. Statistical analysis was performed using SPSS, comparing mean values and using chi-square tests for intergroup comparison of qualitative data, with a significance level of p<0.05.

Results

Table 1: RNFLT & VCDR distribution in both eyes and relation between them (n=40)

	Average RNFLT (In Micrometers)		**VCDR**	
	Right Eye	**Left Eye**	**Right Eye**	**Left Eye**
Mean	79.98	79.15	0.735	0.747
Std. Deviation	11.548	13.917	0.1027	0.0784
Range	75	61	0.6	0.3
Minimum	48	40	0.3	0.6
Maximum	123	101	0.9	0.9
Total Patient	40	40	40	40

Right Eye RNFLT (µm)	**Right Eye VCDR**						**Significance**
	0.3	**0.6**	**0.7**	**0.8**	**0.9**	**Total**	
40-80	00	24	11	07	04	24	χ2=6.022 P=0.019
>80	01	16	10	05	00	16	
Total	01	40	21	12	04	40	

Left Eye RNFLT (µm)	**Left Eye VCDR**						**Significance**
	0.3	**0.6**	**0.7**	**0.8**	**0.9**	**Total**	
40-80	0	00	07	08	05	20	χ2=12.182 P=0.007
>80	0	02	15	03	00	20	
Total	0	02	22	11	05	40	

This table 1 presents key findings from a medical research study on Retinal Nerve Fiber Layer Thickness (RNFLT) in 40 patients. The mean RNFLT for the right eye was 79.98 µm and 79.15 µm for the left eye. Standard deviations were 11.548 µm and 13.917 µm. The range of RNFLT values was 75 µm for the right eye and 61 µm for the left eye, highlighting variations in retinal health within the patient sample. Mean VCDR for the right eye was 0.735, and for the left eye, it was 0.747. Standard deviations were 0.1027 and 0.0784. The range of VCDR values was 0.6 for the right eye and 0.3 for the left eye, providing insights into optic nerve morphology variations within the patient group.

This study examined the correlation between Right Eye Retinal Nerve Fiber Layer Thickness (RNFLT) and Vertical Cup-to-Disc Ratio (VCDR) in two groups: RNFLT 40-80μm and RNFLT >80μm. Among 24 patients with RNFLT 40-80μm, VCDR 0.7 was most common (11 patients), followed by 0.8 (7 patients) and 0.9 (4 patients). In the >80μm group, VCDR 0.7 was again most common (10 patients). The difference between RNFLT and VCDR was statistically significant ($p<0.05$). This study investigated the association between Left Eye Retinal Nerve Fiber Layer Thickness (RNFLT) and Vertical Cup-to-Disc Ratio (VCDR) in two groups: RNFLT 40-80μm and RNFLT >80μm. Among 20 patients with RNFLT 40-80μm, VCDR 0.8 was most common (8 patients), followed by 0.7 (7 patients) and 0.9 (5 patients).

In the >80μm group, VCDR 0.7 was most common (15 patients). The difference between left eye RNFLT and VCDR was statistically significant ($p<0.05$).

Table 2: Association of VCDR and RNFL Thickness with IOP in Right and Left Eyes.

	RE VCDR							**RE AVERAGE RNFL**			
RE IOP (mmHg)	**0.3**	**0.6**	**0.7**	**0.8**	**0.9**	**Total**	**Significance**	**40-80 μm**	**>80 μm**	**Total**	**Significance**
10-20	01	00	00	00	00	01	$\chi2=51.236$ P=0.0001	00	01	01	$\chi2=2.206$ P<0.004
20-30	00	01	15	09	01	26		16	10	26	
30-40	00	01	06	03	02	12		07	05	12	
40-50	00	00	00	00	01	01		01	00	01	
Total	01	02	21	12	04	40		24	16	40	
	LE VCDR							**LE AVERAGE RNFLT**			
LE IOP (mmHg)	**0.3**	**0.6**	**0.7**	**0.8**	**0.9**	**Total**	**Significance**	**40-80 μm**	**>80 μm**	**Total**	**Significance**
10-20	0	0	0	0	0	0	$\chi2=12.591$ P<0.05	0	0	0	$\chi2=3.333$ P< 0.001
20-30	0	02	09	04	00	15		05	10	15	
30-40	0	00	13	07	04	24		14	10	24	
40-50	0	00	00	00	01	01		01	00	01	
Total	0	02	22	11	05	40		20	20	40	

Table 2 showed that among 40 patients, the majority (26) had IOP between 20-30 mmHg, followed by 12 patients with IOP between 30-40 mmHg. One patient each had IOP in the ranges of 10-20 mmHg and 40-50 mmHg. VCDR values varied with IOP ranges, and statistical analysis showed a significant correlation between right eye IOP and right eye VCDR($p<0.05$). The distribution of Intraocular Pressure (IOP) levels was examined. Among them, 24 patients had IOP between 30-40 mmHg, followed by 15 patients with IOP between 20-30 mmHg, and 1 patient with IOP between 40-50 mmHg. Among those with IOP 20-30 mmHg, VCDR analysis revealed 9 patients with 0.7 VCDR, 4 with 0.8, and 2 with 0.6. Similarly, IOP-VCDR associations were observed in other IOP ranges. Statistically significant differences were identified between left eye IOP and VCDR($p<0.05$). This study analysed right eye Retinal Nerve Fiber Layer Thickness (RNFLT) and Intraocular Pressure (IOP) in 40 patients. Among them, 24 had RNFLT between 40-80μm and 16 exceeded 80μm. For the former group, IOP ranged from 20-50 mmHg, and for the latter group, from 10-40 mmHg. Statistically significant correlation between right eye IOP and RNFLT was observed($p<0.05$).This table presents an analysis of left eye Retinal Nerve Fiber Layer Thickness (RNFLT) and Intraocular Pressure (IOP) among 40 patients. Among them, 20 patients had RNFLT values between 40-80 μm, while 20 had RNFLT values exceeding 80 μm. The table further demonstrates the distribution of IOP within different ranges and highlights the statistically significant correlation between left eye IOP and RNFLT ($p<0.05$).

Table 3 depicted that perimetric changes in the right and left eyes were investigated in 40 patients. In the right eye, early changes were observed in 20 patients, followed by paracentral scotoma (13 patients), superior/inferior arcuate scotoma (5 patients), and double arcuate scotoma (1 patient). Among those with early defects, 14 had VCDR 0.7, 6 had VCDR 0.8. In the left eye, early defects were seen in 18 patients, followed by paracentral scotoma (12 patients), superior/inferior arcuate scotoma (7 patients), and double arcuate scotoma (3 patients). Significant associations between perimetric changes and VCDR were noted for both eyes ($p<0.05$).In this study of right eye perimetric changes, among 40 patients, early changes were observed in 20, followed by paracentral scotoma (13), superior/inferior arcuate scotoma (5), and double arcuate scotoma (1). Among those with early defects, 15 had IOP between 20-30 mmHg, 5 had IOP between 30-40 mmHg. Similar associations were found for other types of scotomas. Statistically significant differences between perimetric changes and IOP were noted in the right eye($p<0.05$). The left eye showed comparable trends, with early defects (18), paracentral scotoma (12), superior/inferior arcuate scotoma (7), and double arcuate scotoma (3). Statistically significant differences were also observed between perimetric changes and IOP in the left eye($p<0.05$).Out of 40 patients, 24 had RNFLT between 40-80 micrometres and 16 had RNFLT over 80 micrometres. Among the former, paracentral scotoma was seen in 11, early defects in 7, superior/inferior arcuate scotoma in 5, and double arcuate scotoma in 1. Among the latter, early defects were seen in 13 and paracentral scotoma in 2. Statistically significant differences were noted between right eye perimetric changes and RNFLT($p<0.05$). For the left eye, among 40 patients, 20 had RNFLT between 40-80 micrometres and 20 over 80 micrometres. Among the former, paracentral scotoma (9), inferior arcuate scotoma (6), double arcuate scotoma (3), and early defects (2) were observed. Among the latter, early defects (16), paracentral scotoma (3), and superior/inferior arcuate scotoma (1) were noted. Statistically significant differences were also seen between left eye perimetric changes and RNFLT($p<0.05$).

Table 3: Perimetric Changes and Corresponding VCDR, IOP, and RNFLT Associations in Right and Left Eyes

		PERIMETRY						
		Normal	**Early Defect**	**Paracentral Scotoma**	**Superior/Inferior Arcuate Scotoma**	**Double Arcuate Scotoma**	**Total**	**Sign.**
		Right Eye						
Right Eye VCDR	0.3	1	0	0	0	0	1	$\chi2$=69.273 P <0.0001
	0.6	0	0	1	1	0	2	
	0.7	0	14	5	2	0	21	
	0.8	0	6	6	0	0	12	
	0.9	0	0	1	2	1	4	
Total		1	20	13	5	1	40	
		Left Eye						
Left Eye VCDR	0.6	0	1	0	1	0	2	$\chi2$=46.354 P <0.0001
	0.7	0	13	7	2	0	22	
	0.8	0	4	4	3	0	11	
	0.9	0	0	1	1	3	9	
Total		0	18	12	7	3	40	
		Right Eye						
Right Eye IOP	10-20	1	0	0	0	0	1	$\chi2$=82.337 P<0.0001
	20-30	0	15	7	4	0	26	
	30-40	0	5	6	1	0	12	
	40-50	0	0	0	0	1	1	
Total		1	20	13	5	1	40	
		Left Eye						
Left Eye IOP	10-20	0	0	0	0	0	0	$\chi2$=19.602 P =0.012
	20-30	0	10	3	2	0	15	
	30-40	0	8	9	5	2	24	
	40-50	0	0	0	0	1	1	
Total		0	18	12	7	3	40	
		Right Eye						
Right Eye RNFLT	40-80	0	7	11	5	1	24	$\chi2$=13.990 P =0.016
	>80	1	13	2	0	0	16	
	Total	1	20	13	5	1	40	
		Left Eye						
Left Eye RNFLT	40-80	0	2	9	6	3	20	$\chi2$=23.889 P <0.0001
	>80	0	16	3	1	0	20	
	Total	0	18	12	7	3	40	

Discussion

In this prospective study encompassing 79 eyes from 40 Primary Open Angle Glaucoma (POAG) patients, the interplay between retinal nerve fiber layer (RNFL) thickness, optic disc cupping, and visual field changes was meticulously investigated. Glaucoma management hinges upon visual field analysis and optic disc evaluation, pivotal in early diagnosis and effective intervention. Recognizing that optic disc alterations often antedate visual field defects, the study aimed to underscore the significance of the optic disc assessment in gauging glaucoma and ocular hypertension. This is particularly relevant since glaucomatous optic atrophy precipitates morphological changes including neuroretinal rim loss, deepened optic discs, lamina cribrosa pore exposure, peripapillary atrophy enlargement, and both localized and diffuse RNFL losses, coupled with psychophysical visual field defects.

The current research contributes to a limited body of work that correlates visual field defects with disc morphometry and RNFL loss in glaucoma patients. Pertinently, results align with previous studies, indicating that discernible disc changes and RNFL loss precede visual field deterioration in early and advanced glaucoma stages. Employing Optical Coherence Tomography (OCT) for assessing optic disc and RNFL parameters, and Octopus perimetry machine for visual field defects, the study meticulously scrutinized the dataset.

Age distribution analysis revealed a preponderance of POAG patients (67.5%) within the 50-60 age range, and the mean age of patients was 50.73±7.331 years. Comparable to Pankaj Soni et al.'s findings, the 6th and 7th decades of life hosted the maximum patient representation. [7]Gender's complex influence on glaucoma prevalence is evident, with studies showing inconsistent trends. In this study, 57.5% were male and 42.5% were female, akin to Soni et al., while Hong et al. observed a slightly higher prevalence in males (54.2%).[7,8] Intraocular pressure (IOP) remains a paramount risk factor in POAG, emphasized by the study's findings aligning with existing research. Additionally, the cup-to-disc ratio (CDR) emerged as a significant parameter in this investigation. Mean vertical CDR was 0.735±0.1027 in right eyes and 0.747±0.0784 in left eyes. These values resonate with prior research by Gyasi et al., Pankaj et al., and Wensor et al. [7,9,10]The study's assessment of visual field patterns in early damage deepens our understanding of glaucomatous optic nerve pathophysiology. Early defects, paracentral scotomas, and arcuate scotomas were identified, unveiling the evolving damage. Notably, RNFL loss emerged as a pivotal predictor of glaucomatous damage. Mean average RNFL thickness was in concordance with existing studies. The study affirmed significant correlations between IOP, CDR, RNFL thickness, and visual field defects, thus reinforcing their interconnectedness in glaucoma progression.

Conclusion

This prospective study successfully established correlations between RNFL thickness, optic disc cupping, and visual field defects in POAG patients. The findings underscore the importance of optic disc evaluation, RNFL thickness measurement, and visual field analysis in early glaucoma management. Our results align with existing literature, emphasizing the reproducibility and clinical relevance of these relationships. Further research can continue to elucidate the intricacies of these associations, contributing to more effective POAG diagnosis and treatment strategies.

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References

1. Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. Br J Ophthalmol. 2012; 96:614-8.
2. Murthy GV, Gupta SK, Bachani D, Jose R, John N. Current estimates of blindness in India. British Journal of Ophthalmology. 2005 Mar 1; 89(3):257-60.
3. Sreedevi KV, Kumar MP, Deepthi SD. A Clinical Study to Correlate Visual Field Defects with Optic Disc Changes in 100 Patients with Primary Open Angle Glaucoma in A Tertiary Eye Care Hospital.
4. Leske MC, Connell AM, Schachat AP, Hyman L. The Barbados Eye Study. Prevalence of open-angle glaucoma. Arch Ophthalmol. 1994; 112:821- 829.
5. Marmor MF, Kellner U, Lai TY, Melles RB, Mieler WF. American academy of ophthalmology. Recommendations on screening for chloroquine and hydroxyl chloroquine retinopathy (2016 revision). Ophthalmology. 2016 Mar; 123(6):1386-94.
6. Leske MC, Connell AM, Schachat AP, Hyman L. The Barbados Eye Study: prevalence of open angle glaucoma. Archives of ophthalmology. 1994 Jun 1; 112(6):821-9.
7. Pankaj Soni, Ashwani Srivastava, Akash Srivastava, Deepti Yadav “Study of correlation of cup disc ratio with visual field loss in POAG”, 2017;24-50.
8. Kang JH, Loomis SJ, Rosner BA, Wiggs JL, Pasquale LR. Comparison of risk factor profiles for primary open-angle glaucoma subtypes defined by pattern of visual field loss: a prospective study. Investigative

Ophthalmology & Visual Science. 2015 Apr 1; 56(4):2439-48.

9. Gyasi M, Amoko W, Adjuik M, Presentation pattern of primary open-angle glaucoma in Northeastern Ghana. Ghana Med J, 2010; 44(1): 25-30.
10. Wensor MD, McCarty CA, Stanislavsky YL, Livingston PM, Taylor HR. The prevalence of glaucoma in the Melbourne Visual Impairment Project. Ophthalmology. 1998 Apr 1; 105(4): 733-9.