Section: Ophthalmology

Research

A COMPARATIVE STUDY OF VISUAL FIELD DEFECTS WITH OPTIC DISC CHANGES IN PRIMARY OPEN ANGLE GLAUCOMA IN NORTHERN WEST RAJASTHAN

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Abstract

Background: Glaucoma a progressive optic neuropathy characterized by loss of retinal ganglion cells and manifests clinically as loss of neuroretinal rim tissue, localized and diffuse defects of retinal nerve fiber layer (RNFL) and deficits in functional visual field testing (VF). The objectives are- 1. To quantify the loss of visual function by Humphrey's field analyser 2. Evaluation of optic nerve head by both direct ophthalmoscopy and slit lamp bio-microscopy. **Materials and Methods:** Study Design: Prospective hospital based observational study. Study area: Aacharya Nanesh Rotary Eye Hospital, Glucoma Clinic Department of Ophthalmology. Study Period: July 2021 - June 2022. Study population: Primary open-angle glaucoma patients who came to the Department of ophthalmology Glucoma Clinic Aacharya Nanesh Rotary Eye hospital; Bikaner, Rajasthan. Sample size: Study was done on 100 patients. Sampling method: Simple Random sampling method. Study tools and Data collection procedure:1. Relevant history of the patient was taken 2. Visual acuity measured by the Snellen's visual acuity charts & best corrected visual acuity was given. 3. Slit lamp examination done to evaluate anterior segment. 4. Corrected Intraocular pressure measured by Goldmann applanation tonometry. 5. Gonioscopy done by Goldmann 4 mirror gonioscope. 6.Visual field examimation by HFA 30-2 .7 Slit Lamp Biomicroscopic Fundus examination with 90 D. **Result:** Inferior NRR notch and inferior and superior NRRthinning were increased prevalence compared to other disc changes. Disc hemorrhages were more commonly seen in normal-tension glaucoma 25% than in primary open-angle glaucoma (Bruce shields). **Conclusion:** Based on results we conclude that disc changes have their importance in early stages of glaucoma and visual field defects in correlation with disc changes are of significance in prognosis and progression of primary open angle glaucoma.

INTRODUCTION

Glaucoma a progressive optic neuropathy characterized by loss of retinal ganglion cells and manifests clinically as loss of neuroretinal rim tissue, localized and diffuse defects of retinal nerve fiber layer (RNFL) and deficits in functional visual field testing (VF).[1]

Glaucoma is the most important cause of world blindness after cataracts. Worldwide, the prevalence of glaucoma is increasing, and 60 million people have diagnosed with this condition. It is expected to affect 111.8 million people by 2040. The prevalence of open-angle glaucoma is reported to be highest in Africa and that of narrow-angle in Asia.[2]

In a systematic meta-analysis, the global prevalence of glaucoma was found to be 3.54%. Asians represent 47% of those with glaucoma and 87% of those with angle-closure glaucoma (ACG). India report for a minimum of 12.9% of primary open-angle glaucoma (POAG) blindness and 12.7% of PACG (PACG) blindness in the world these figures expected to be double by 2020.[2]

The regional burden of blindness (RBB) is highest for India (23.5%) of global blindness, with at least 5.8 million blind due to glaucoma. POAG is the autosomal dominant disease representing approximately ½ of all cases of glaucoma worldwide.[3]

Glaucoma is a significant cause of ocular morbidity worldwide. It is the second leading cause of world

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blindness accounts for 15% of global blindness.[4] The target for the 10th five-year plan is to reduce the prevalence of blindness to 0.8% by 2007 from 1.1% in 2001-2003. "Facilities for early diagnosis and treatment of glaucoma" is included in this plan. India accounts for the risk of 12.9% of POAG blindness and 12.7% of PACG blindness in the world. These are expected to be double by 2020 AD.[5] Glaucoma is estimated to affect 12 million Indians and causes 12.8% of the total blindness in the country and is considered to be the 3rd most common cause of blindness in India.[6,7]

It has estimated that by the year 2010, 60.5 million people would have been burden by glaucoma and that by 2020, there would be 79.6 million sufferers, 47% of glaucomas worldwide would be in Asia.[8]

Glaucoma describes a group of disorders that have in chronic degeneration of optic nerve associated with typical visual field defects and usually elevated IOP. If left untreated, it results in irreversible blindness.[9]

The term glaucoma does not indicate a disease entity but has a composite of pathological conditions which have the common feature that their clinical manifestations are to a greater or lesser extent dominated by the height of intraocular pressure and its consequences.[10]

The blindness of glaucoma can be prevented by early recognition and proper treatment of the disease. Tonometry has identified as a standard method for measuring intraocular pressure in patients. If the management based on single intraocular pressure measurement, a large percentage of the population who do not have glaucoma required to undergo costly follow-up evaluations while a smaller but clinically more significant group of individuals who do have glaucoma are free of disease.[11]

Visual field (VF) testing is an essential diagnostic tool in the evaluation of patients with various pathologies affecting the optic nerve and neuro-ophthalmological diseases. The current gold standard for visual field testing is automated perimetry.[11] Automated perimetry is a widely used method to assess VF deficit in glaucoma; it is more practical and efficient than intraocular pressure measurement alone in treating POAG. Interpretation of visual field printout and clinical correlation are essential to make a meaningful diagnosis. Humphrey Field Analyzer is an automated perimeter intended to measure VF using static stimuli, and advanced Guided Progression Analysis (GPA) helps to recognize and monitor increasing VF loss due to glaucoma.[12]

Since the progressive loss of visual function is the ultimate result in all forms of glaucoma, visual function screening tests may offer the most sensitive and specific method of detecting established cases.

Humphrey field analyzer is mandatory in the management and follows up with glaucoma patients. While defects related to loss of retinal nerve fiber bundles are the most frequent visual field changes and central vision is usually one of the last regions to be lost. Studies are now showing a mild central and diffuse reduction in the visual field, even in the early stage of glaucoma.[12]

Objectives

1. To quantify the loss of visual function by Humphrey's field analyzer
2. Evaluation of optic nerve head by both direct ophthalmoscopy and slit lamp bio- microscopy.
   a) To evaluate optic disc size and shape
   b) To evaluate neuro-retinal rim size and shape
   c) To evaluate the optic cup size to optic disc size
   d) To evaluate optic cup shape and depth
   e) To identify peripapillary atrophy
   f) To identify optic disc hemorrhages if any
   g) To identify vascular changes on the surface of the disc
3. Correlation of optic nerve head and visual field defects

MATERIALS AND METHODS

Study Design: Prospective hospital based observational study.

Study area: Department of Ophthalmology, Aacharya Nanesh Rotary Eye Hospital, Glucoma Clinic.

Study Period: July 2021 - June 2022.

Study population: Primary open-angle glaucoma patients who came to the Department of ophthalmology.

Sample size: Study was done on 100 patients.

Sampling method: Simple Random sampling method.

Inclusion Criteria

- Females/males above 40years.
- Vertical cup disc ratio > 0.5
- Asymmetry in vertical cup disc ratio more than 0.2 between two eyes
- Neuro retinal rim changes like thinning, notching and pallor
- Open angles on gonioscopy

Exclusion Criteria

- Patients with corneal opacities and significant cataracts
- Patients with aphakia.
- Patients with any previous ocular trauma.
- patients with less visual acuity who cannot perform fields.

Ethical consideration: Institutional Ethical committee permission was taken prior to the commencement of the study.

Study Tools and Data Collection Procedure

- Relevant history of the patient was taken
- Visual acuity measured by the Snellen's visual acuity charts & best corrected visual acuity was given.

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- Slit lamp examination done to evaluate anterior segment.
- Corrected Intraocular pressure measured by Goldmann applanation tonometry.
- Gonioscopy done by Goldmann 4 mirror gonioscope.
- Disc evaluation by both direct ophthalmoscopy and slit-lamp biomicroscopy using +78D and +90D lenses.
- Fundus photography by canon digital camera.
- Visual field examination by Humphrey's automated visual field analyzer type- II – 720 i series standard white on white perimetry, SITA strategy with 30-2, 24- 2, 10-2 done.

Statistical Analysis

The statistical analysis will be carried out using IBM SPSS (Statistical Package for Social Sciences) statistical version 21. The analysis includes frequency table, bar, pie chart, association of variables based on Chi-square. All quantitative variables will be estimated using measures of central location "mean" and measures of dispersion (standard deviation). For normally distributed data, Mean will be compared using independent t-test (for two groups). For not normality distributed data, Median will be compared using Mann Whitney U test (for two groups). For relationship Pearson Correlation method will be used using chi square test.

RESULTS

Of the 100 patients, there were 34 males and 66 females. Higher prevalence and incidence rates was observed in females compared to males.

Table 1: Sex Distribution

S.No	Sex	Total No of cases	Percentage (%)
1.	Male	34	34%
2.	Female	66	66%

Of the 100 patients, there were 34 males and 66 females. Higher prevalence and incidence rates was observed in females compared to males.

Table 2: Age Specific Prevalence of Primary Open Angle Glaucoma

S.No	Age in (years)	No. Of cases	Percentage (%)
1	41– 50	18	18%
2	51 – 60	45	45%
3	61 – 70	31	31%
4	> 70	6	6%

Peak prevalence of primary open-angle glaucoma is in 51 – 60 years age group in our study.

Table 3: Intraocular Pressure Distribution in Primary Open Angle Glaucoma

S.No	Intraocular pressure	No of eyes	Percentage (%)
1	10 – 20	45	22.5%
2	21 – 30	124	62%
3	>31	31	15.5%

There is a strong relationship between intraocular pressure and glaucoma.

Table 4: Prevalence of Field Defects in Primary Open Angle Glaucoma

S.No	Type of Field defect	No. Of Eyes showing field defect
1	Isolated field defects	17
2	Seidel's scotoma	9
3	Arcuate scotoma	74
4	Biarcuate scotoma	36
5	Tubular vision	21
6	Without field changes	43

Arcuate scotomas were of increased prevalence.

Table 5: Prevalence of Disc Changes in Primary Open Angle Glaucoma

S.No	Types of disc changes	No Of eyes showing disc changes
1	Normal NRR	38
2	Slope of Inf temp NRR	17
3	Inf NRR Notch	42
4	Sup NRR Notch	34
5	Inf & Sup NRR THINNING	42
6	Total loss of NRR	22
7	Inf &sup nrr notching	5
8	Disc hemorrhage	3

Inferior NRR notch and inferior and superior NRR thinning were increased prevalence compared to other disc changes. Disc hemorrhages were more commonly seen in normal-tension glaucoma 25% than in primary open-angle glaucoma (Bruce shields).

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Table 6: Preavlance of Disc Changes in Both Eyes

Optic Nerve Head	OD (%)	OS (%)
Normal NRR	16 (16%)	22 (22%)
Slope of Inf temp NRR	8 (8%)	9 (9%)
Inf NRR Notch	23 (23%)	19 (19%)
Sup NRR Notch	21 (21%)	13 (13%)
Inf & Sup NRR THINNING	19 (19%)	23 (23%)
Total loss of NRR	10 (10%)	12(12%)
Sup & Inf. Rim Notch	3 (3%)	2(2%)
Total	100 (100%)	100 (100%)

Table 7: Prevalence of Visual Field Changes in Both Eyes

Visual Field	OD (%)	OS (%)
Normal	15 (15%)	28 (28%)
SIPCS	3 (3%)	2 (2%)
SAS	22 (22%)	15 (15%)
SS	7 (7%)	2 (2%)
BAS	19 (19%)	17 (17%)
IAS	13 (13%)	6 (6%)
INS	2 (2%)	3 (3%)
SPAS, IAS	0 (0%)	2 (2%)
IPCS	6 (6%)	1 (1%)
TV	8 (8%)	13(13%)
SAS & IPAS	3(3%)	4 (4%)
SAS & IPCS	2(2%)	2 (2%)
IPAS	0(0%)	5 (5%)
TOTAL	100 (100%)	100 (100%)

Table 8: Comparison of disc changes and visual field changes in right eye

Optic Nerve Head OD	Normal	SIPCS	SAS	SS	BAS	IAS	INS	IPCS	TV	SAS & IPAS	IAS & SPAS	Total
Normal NRR	15	0	0	0	1	0	0	0	0	0	0	16
Slope of Inf temp NRR	0	1	0	5	0	0	0	2	0	0	0	8
Inf. NRR Notch	0	2	19	0	0	0	0	0	0	1	0	23
Sup NRR Notch	0	0	3	2	1	12	1	2	0	0	0	21
Inf & Sup NRR Thinning	0	0	0	0	15	1	1	0	1	1	1	19
Total Loss of NRR	0	0	0	0	0	0	0	2	6	1	1	10
Sup & Inf Rim Notch	0	0	0	0	2	0	0	0	1	0	0	3
Total	15	3	22	7	19	13	2	6	8	3	2	100

Using Pearson's Correlation value is 0.693 and the p value is 0.0001 ($P < 0.05$) Significant.

Table 9: Comparision of disc changes and visual fields changes in left eye

Optic Nerve Head OS		SIPCS	SAS	SS	BAS	IAS	INS	SPAS & IAS	IPCS	TV	SAS & IPAS	SAS & IPCS	IPAS	Total
Normal NRR	18	0	0	1	0	0	1	0	0	0	0	0	2	22
Slope of Inf temp NRR	5	2	0	1	0	0	0	0	1	0	0	0	0	9
Inf. NRR	4	0	12	1	7	0	0	0	0	0	0	0	0	19

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Notch														
Sup NRR Notch	0	0	0	0	0	6	2	0	1	0	0	0	2	13
Inf & Sup NRR thinning	1	0	3	0	9	0	0	2	0	1	4	2	1	23
Total Loss of NRR	0	0	0	0	1	0	0	0	0	11	0	0	0	12
Sup and inf notch	0	0	0	0	0	0	0	0	0	1	0	0	0	2
Total	28	2	15	2	17	6	3	2	1	12	4	2	5	100

Using Pearson's Correlation value is 0.808 and the p value is 0.0001 ($P < 0.05$) Significant

Table 10: Correlation IN BOTH EYES

		Optic Nerve Head OD	Visual Fields OD	Optic Nerve Head OS	Visual Fields OS
Optic Nerve Head OD	Pearson Correlation	1	.693**	.334**	.227*
	Sig. (2-tailed)		.000	.001	.023
	N	100	100	100	100
Visual Fields OD	Pearson Correlation	.693**	1	.225*	.155
	Sig. (2-tailed)	.000		.024	.124
	N	100	100	100	100
Optic Nerve Head OS	Pearson Correlation	.334**	.225*	1	.808**
	Sig. (2-tailed)	.001	.024		.000
	N	100	100	100	100
Visual Fields OS	Pearson Correlation	.227*	.155	.808**	1
	Sig. (2-tailed)	.023	.124	.000	
	N	100	100	100	100

DISCUSSION

In most cases, the disc changes occur before the visual field loss, so the optic disc assessment is vital for the evaluation of glaucoma, ocular hypertension. Glaucomatous optic atrophy leads to morphological changes such as loss of neuroretinal rim, deepening of the optic disc, lamina cribrosa pores, enlargement of the peripapillary atrophy and localized and diffuse loss of the retinal nerve fiber layer and psychophysical defect such as visual field defect.

Of the 100 patients, there were 34 males and 66 females indicating the prevalence of primary open-angle glaucoma. Higher prevalence and incidence rates were observed in females compared to males.

In the study by Pankaj soni 60 patients,[13] 31 (51.66%) were male and 29 (48.33%) female, showed no gender preponderance. Al Mansouri F,[14] in Qatar prevalence was more in females (58.4%) than males (41.6%) and the study by prempaul Kaur,[15] showed that 30% of the patients were males and 70% females.

Peak prevalence of primary open-angle glaucoma is found in 50-70 years age group in this study Is 45%. This is in concordance with published data on primary open-angle glaucoma Friedman et al.; 2004 Baltimore eye survey and Praveen tadke et al.[16] In a study, Das J et al.[17] Found a mean age of glaucoma to be 60.54 years. In a study by prempal Kaur et al.[15] Showed the maximum number of patients were in the age group of 50-59 years (39%) and 60-69 (39%) years.

Intraocular pressure the most significant risk factor for POAG, and indeed, the only risk factor that can be modulated. In our study of 200 eyes,124 eyes showed IOP in the range was in 21-30 mmHg. The mean IOP of 114 eyes in the Pankaj soni et al,[13] the study was found to be 29.92mm Hg.12 eyes (10.52%) had IOP in range of 21-24 mmHg, 52 eyes (45.61%) had IOP in range of 25-29 mmHg, 48 eyes (42.10%) had IOP in range of 30-34 and 2 eyes (1.75%) with IOP > 35 mmHg. Chul Hong et al,[18] the study of 206 Korean glaucomatous patients, found that the mean IOP of POAG patients was 33.4±15.5 mm Hg.

In our study, the mean IOP of 200 eyes was slightly lower because the maximum number of patients included were known POAG patients already on antiglaucoma medication. There is a strong dose-response relationship between intraocular pressure and glaucoma that has consistently been shown in prevalence surveys Ahmad S. S, Mahabadi N,[19,20], and in longitudinal studies of incidence and progressions (Baltimore eye survey). This similar relationship is maintained in our study. In the Baltimore survey, the prevalence of primary open-angle glaucoma increased with intraocular pressure. Compared to those with an IOP below 15 mm of Hg, the prevalence of primary open-angle glaucoma was over 40 times in those with an IOP of 35 or higher.

Disc cupping increased proportionately with increase in intraocular pressure, thus establishing progression of glaucoma with rising in IOP, Barbara E. K. Klein, A. Azuara-Blanco, Ali Poostchi,[21-23]

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population-based study reported that the incidence of primary open-angle glaucoma for those with a baseline cup disc ratio of more than 0.7 was 8.6 fold higher than for those with cup disc ratio of less than 0.7(Bruce shields, 5th edition) Gyasi et al.[24] study showed association with high (IOP> 30 mmHg) and vertical c:d ratio =1.0 (p<0.001). In this study, 84 eyes out of 200 eyes had 0.7-0.8 cupping.

Another study by Rohit Varma et al,[25] studied 3939 patients for both baseline and the 4-year incidence of OAG in the first eye (among those without OAG at baseline) was 2.3% (95% CI, 1.8%-2.9%). The incidence in the second eye (among those who had OAG in one eye at baseline) was about 6-fold that in the first eye, with 11 of 91 persons (12.1%, 95%CI, 5.4%-18.8%) developing OAG after four years. Baseline factors are significantly predictive of the development of POAG. Though horizontal and vertical cup-disc ratios were highly correlated (r = 0.92), Mae O. Gordon et al,[26] reported, the vertical cup-disc ratio was a slightly better predictor for the development of POAG than the horizontal cup-disc ratio. Therefore, the vertical cup-disc ratio included in the multivariate risk model, and the horizontal cup-disc ratio was not.

While in view of other parameters of the optic nerve head, it is seen that the most accurate judge of field loss was the presence or absence of notching. In our study, inferior NRR notch (42) and inferior &superior NRR thinning (42) were of increased prevalence compared to other disc changes. Arcuate scotomas (74out of 200 eyes) were of increased prevalence as most of these patients are asymptomatic and present to the hospital when the considerable loss of vision has set in. Similar findings reported in many studies. Ewa Kosior-Jarecka.[27]

In a study by Pankaj soni et al,[13] Notching was present in 35 cases in a superior quadrant, of which corresponding inferior field defect was calculated in 94.3% cases. Eighteen patients had inferior quadrant notching, and (100%) all of them showed corresponding visual field defects. Thus inferior quadrant notching was an even more accurate predictor of field loss. These results are in agreement with Hitchings and Spaeth.[28] In which 83.5% and 91% accuracy in predicting superior and inferior defects, respectively.

In our study, patients were found to have a prevalence of arcuate visual field defects, which correlated with superior NRR notch and inferior NRR notch on a routine fundus examination. This is under the study by Nilay B et al,[29] study significant correlation between C/D ratio and loss variance at p<0.05. Also, the severity of scotomas increased in advanced cases with a higher C/D ratio.

Other disc parameters which were important in predicting field defects Were-Baring of vessels with nasalization of vessels- which have high specificity in predicting field defects, bayonetting of vessels, Parapapillary atrophy–beta zone atrophy, Laminar dot sign, was found in the glaucomatous patients very commonly while it was uncommon in non-glaucomatous cases, but alpha zone atrophy commonly present in both glaucomatous as well as non-glaucomatous eyes.

Correlation between visual field defects and optic nerve head in glaucoma is close enough to prompt a search for other disease processes such as neurologic disorders if a correlation is not found. If The perfect correlation is absent indicates that both disc and field examinations are essential in managing the glaucoma patient. In general, optic nerve head changes have their most significant value in the early stages of glaucoma, where a progressive visual field loss becomes the more useful guide to therapy in advanced cases**.**

Atsuya Miki et al,[30] in 2012 also concluded that imaging devices are promising tools for monitoring patients with glaucoma but combining structural and functional analyses is useful for accurate monitoring of glaucoma progression.

CONCLUSION

Based on results we conclude that disc changes have their importance in early stages of glaucoma and visual field defects in correlation with disc changes are of significance in prognosis and progression of primary open angle glaucoma.

As OCT and other diagnostics like Heidelberg retinal tomography are expensive, testing of Visual fields is the primary method of assessing visual function in glaucoma patients & glaucoma suspects. Automated static perimetry using white stimulus projected on to a white background is most commonly performed Visual Field test in glaucoma with Humphrey field analyzer, which helps in regular follow-ups and further management.

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