



CLINICAL CORRELATION BETWEEN OPTIC DISC CHANGES AND VISUAL FIELD DEFECTS IN PATIENTS OF PRIMARY OPEN ANGLE GLAUCOMA AT A TERTIARY CARE CENTER

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ABSTRACT

Aim: To evaluate optic disc changes and changes in the visual field, and to establish a correlation between structural and functional damage in glaucomatous eyes.

Material and Methods: The present study is a prospective observational study. It was carried out in the Department of Ophthalmology, at Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly from April 2013 to April 2014. Seventy primary open angle glaucoma subjects constituted the study material for this prospective study. These patients were evaluated for optic nerve head changes and visual field changes.

Results: The study comprised of 70 cases of glaucoma that includes 39 males and 31 females. The prevalence of POAG was highest among 51-60 yrs age group, 38 (50.66%) of which 26 (34.66 %) were male and 12 (16.00%) were female. Majority of the POAG patients had C:D ratio between 0.6 – 0.7. Out of 136 eyes, 72 (52.94%) had C:D ratio at presentation in the range of 0.6 – 0.7. There was considerable overlapping among different ONH findings. Co-existent disc, vascular and peripapillary changes was very common. Purely diffuse field loss due to glaucoma was observed in 8% eyes, whereas, combination of localized and diffuse field loss was present in majority of eyes. Of all eyes (n = 136), 48 had no defect. Upper field defects were found in 39 eyes; 35 eyes had lower field defects and combined defect was found in 12 eyes. Of the upper and lower cases, the type of defects included nasal step in 24 eyes, arcuate defect in 29 eyes and nasal & temporal quadrant involvement in 41 & 4 eyes respectively. Diffuse RNFL loss was found in 34 eyes with definite visual field defect in all (100%) cases. Localized RNFL damage was present in 22 eyes, among which 20 eyes were found to have definite field loss but 2 eyes showed no VFD in automated perimetry.

Conclusion: There are significant correlations between the parameters of optic disc and MDs of HFA in all patients with open angle glaucoma. Thus the visual field defect in the patients of primary open angle glaucoma corresponds to optic disc cupping and neuroretinal rim loss.

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INTRODUCTION

Glaucoma in all its forms is a major cause of irreversible blindness throughout the world. As the disease per se cannot be prevented but the sequelae of the disease are largely preventable; only if early diagnosis and management is done before irreparable loss has occurred. But unfortunately ignorance on the part of the patients and lack of infrastructure and facilities for ophthalmologists, in many borderline cases the disease advances and irreversibly proceeds.

Amounting to second major cause of blindness in the world after cataract, it is estimated that there are about 66.8 million¹ suffering from glaucoma worldwide with 6.7 million suffering from bilateral blindness. Chronic simple Glaucoma (CSG) is expected to affect 33 million people worldwide, majority of whom reside in developing countries.

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In India, glaucoma [according to NPCB²] is the third major cause of blindness after cataract and refractive errors accounting to about 5.80% of the total blindness in the country. WHO-NPCB³ survey showed that India accounts 12.9% of the CSG cases in the world and PACG the contribution is around 12.7%. To evaluate the quantitative relationship between morphometrically measurable defects of the optic nerve head and measurable functional defects, we first examined the visual field with static computerized perimetry and then the optic disc was evaluated by fundus photography.

Visual field loss in Glaucoma

Each location in the retina corresponds to a certain direction in the visual field. A particular location in the nasal retina corresponds to a location in the temporal visual field. Similarly, the inferior retina represents the superior visual field. The point that separates the nasal from the temporal side is the fovea, which represents the point of fixation. Nerve

fibers pass from every point in the retina to the optic nerve head, and the character of field defects is affected by the pathway of the nerve fibers. From the nasal retina, the fibers take a straight course to the nasal portion of the disc.

From the region temporal to the disc and nasal to the fovea, the fibers pass fairly directly towards the temporal margin of the disc. Fibers from the retina temporal to the fovea extend in an arcuate pathway around the fovea and pass into the upper and lower poles of the disc.⁵

Automated perimetry-Humphrey field analyser⁵

Perimetry, when performed well and frequently, can be extremely useful in detecting progressive visual field loss. Unfortunately, visual field analysis may not be sensitive enough in the detection of early glaucomatous disease, as structural changes indicative of damage may occur.

1. To study the glaucomatous Optic Nerve Head (ONH) changes.
2. To find out the visual field (VF) changes using automated perimeter.
3. To investigate the relationship of optic disc changes and changes in the visual field, to establish a correlation between structural and functional damage in glaucomatous eyes.

MATERIAL AND METHODS

The present study is a prospective observational study. It was carried out in the Department of Ophthalmology, at Shri Ram Murli Smarak Institute of Medical Sciences, Bareilly from April 2013 to April 2014.

Patient selection: Seventy primary open angle glaucoma subjects constituted the study material for this prospective study.

The initial criteria for diagnosis or suspecting glaucoma were

1. History (symptoms) or initial Slit lamp examination (signs) suggestive of glaucoma
2. An IOP measurement of >21 mmHg (using both Schiottz and Applanation tonometer) at presentation.
3. Glaucomatous optic nerve head changes (by Direct Ophthalmoscopy, Slit lamp Indirect Biomicroscopy with 90D lens & fundus photography).
4. Gonioscopic evidence of open angle.
5. Classical visual field (VF) defects on automated static perimetry.
6. Already diagnosed cases (surgery done or on antiglaucoma medication).

Inclusion criteria were: Age above 40 yrs, Patients of either sex, Diagnosed with primary open angle glaucoma (baseline IOP > 22 mmHg), Characteristic optic disc changes, Reliable baseline fields with defects. Best corrected visual acuity < 6/60 and better.

Exclusion criteria were: BCVA ≥ 6/60. Unreliable field. Subjects who could not follow the command of the examiner due to illness or any other reason. Presence of any other disease (apart from glaucoma) which could affect the performance during testing or could simulate glaucomatous VF abnormality. Any other ocular diseases except for OAG was present; Systemic diseases affecting the visual fields were present; had undergone intraocular surgery; and cataract

progression during the follow-up period. Patients with peripheral anterior synechiae. Patients with signs of uveitis. Patients with H/o shock and haemorrhage, use of topical steroids. Patients with H/o hypertension on treatment with systemic beta blockers. Patients with high refractive error, spherical > 5D, cylinder > 3D. Patients with burnout pigmentary glaucoma, advanced diabetic retinopathy. Patients with advanced cataract, diabetic retinopathy. Patients who have undergone cataract surgery.

Patient assessment

All patients were scrutinized through detailed history regarding their complaints and risk factors of glaucoma. After general & systemic examination, a thorough ocular examination including best corrected visual acuity (BCVA), anterior segment, fundus examination and specific tests for glaucoma such as VF & Gonioscopy were carried out in each patient.

1. A brief history regarding any medications (ocular & systemic) including duration & frequency were recorded. History of ocular surgery or injury, if any, was also recorded.
2. History of any systemic illness (CVS, CNS, Respiratory system, Diabetes, Thyroid disorder, Migraine) was also enquired and recorded.
3. Family history of glaucoma or any other ocular disease e.g. high myopia, diabetes, hypertension, hypothyroidism, migraine was recorded.
4. A brief examination of CVS, CNS and Respiratory Systems was carried out.
5. The baseline clinical parameters including age, gender, and refractive error for each patient were recorded.

Statistical Method: Descriptive statistical analysis was carried out in the study. Results on continuous measurements were presented on Mean ± SD (Min-Max) and results on categorical measurements were presented in Number (%). Significance was assessed at 5% level of significance. Student “t” test was used to find the significance of study parameters on continuous scale between two groups (Inter group analysis). Chi-square, 2x2, 2x3 Fisher Exact test was used to find the significance of study parameters on categorical scale

RESULTS

The present study was carried out in the Department of Ophthalmology, at Shri Ram Murli Smarak Institute of Medical Sciences, Bareilly from April 2013 to April 2014. It comprised of 70 cases of glaucoma that includes 39 males and 31 females.

Table 1 Age and Sex wise Distribution of Cases.

Age in years	POAG Patients	
	M	F
10 - 20	-	-
21 - 30	-	-
31 - 40	02	-
41 - 50	04	02
51 - 60	26	12
61 - 70	14	08
> 70	02	-
Total	48	22

The prevalence of POAG was highest among 51-60 yrs age group, 38 (50.66%) of which 26 (34.66 %) were male and 12 (16.00%) were female.

Table 2 Distribution of Eyes According to Cup-Disc Ratio

Cup : Disc	Eyes of POAG patients
≤0.3	9
0.4	14
0.5	23
0.6	39
0.7	33
0.8	12
≥0.9	6
Total	136

Majority of the POAG patients had C: D between 0.6 – 0.7. Out of 136 eyes, 72 (52.94%) had C: D at presentation in the range of 0.6 – 0.7.

Table 3 Distribution of Eyes According to Specific Type of Optic Nerve Head (ONH) Findings

ONH features	No. of Eyes (n = 136)	Percentage (%)
Generalized enlargement of cup	113	83.08
Focal notching	17	12.5
Pale NRR (Disc pallor)	82	60.29
Baring of circumlinear vessels	95	69.85
Nasal shifting &/or Bayoneting sign	75	55.14
Disc hemorrhage	17	12.5
Peripapillary atrophy (Enlarged zone β)	77	56.61
RNFL damage	56	41.17

There was considerable overlapping among different ONH features. Co-existent disc, vascular and peripapillary changes was very common.

Table 4 Distribution of Eyes According to the type of Visual Field Defects

Field defect	No. of Eyes	Percentage (%)
Normal field	48	35.29
Localized defect	21	15.44
Purely diffuse loss	11	8.08
Mixture of localized & diffuse loss	54	39.7

Purely diffuse field loss due to glaucoma was observed in 8% eyes, whereas, combination of localized and diffuse field loss was present in majority of eyes.

Table 5 Number and Distribution of Eyes in each Category of Field Defect

Field defect or Quadrant involved	No. of Eyes
1. No defect	48
2. Upper defect	39
* Superior Arcuate (SA)	15
* Superonasal Quadrant (SNQ)	21
* Superotemporal Quadrant (STQ)	3
3. Lower defect	35
* Inferior Arcuate (IA)	14
* Inferonasal Quadrant (INQ)	20
* Inferotemporal Quadrant (ITQ)	1
4. Combined defect	12
5. Arcuate extension of blind spot (AEBS)	8
6. Nasal step (NS)	24

Of all eyes (n = 136), 48 had no defect. Upper field defects were found in 39 eyes; 35 eyes had lower field defects and combined defect was found in 12 eyes. Of the upper and lower

cases, the type of defects included nasal step in 24 eyes, arcuate defect in 29 eyes and nasal & temporal quadrant involvement in 41 & 4 eyes respectively.

Table 6 Relationship of Visual Field Damage with mean Age, IOP & C:D

Mean Values	No VFD (n = 48)	VFD, not advanced (n = 64)	AVFD (n = 24)
Age (yrs)	48.23	53.3	58.05
IOP (mmHg)	24.4	35.5	37.0
Cup : Disc	0.47	0.62	0.76

The above table clearly shows a direct relationship of advanced visual field damage (AVFD) with increasing age group, higher IOP level and larger cup disc ratio.

Table 7 Co-relation of ONH features with VF involvement (DISC CHANGES).

ONH features (DISC) (No. of eyes)	FIELD DEFECTS								AEBS (n=8)	Comments
	No defect (n=48)	SA (n=15)	IA (n=14)	SNQ (n=21)	INQ (n=20)	STQ (n=3)	ITQ (n=1)	Combined Defect (n=12)		
Generalized enlargement of cup (113)	35 [30.9%]	11 [9.7%]	12 [10.6%]	17 [15.0%]	18 [15.9%]	3 [2.6%]	1 [0.8%]	12 [10.6%]	8 [7.1%]	No definite relation with specific types of field defect
Focal Notching (17)	4 [23.5%]	4 [23.5%]	3 [17.6%]	4 [23.5%]	2 [11.7%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	Co-relates highly (76.5%) with specific area, type or quadrant involvement
Pale NRR (82)	11 [13.4%]	10 [12.2%]	12 [14.6%]	16 [19.5%]	17 [20.7%]	3 [3.6%]	1 [1.2%]	12 [14.6%]	8 [9.7%]	No definite relation with specific types of field defect

Among the disc changes, a very good co-relation was found between focal notch formation of NRR and corresponding area of field damage. 30.9% eyes had generalized enlargement of cup with no field defects. Also, disc pallor was found in a large number of eyes having various types of VF defects.

Table 8 RNFL damage and VF defect

RNFL damage	No. of eyes	VF defect	Percentage
Diffuse	34	34	100%
Localized	22	20	90.9%
Total	56	54	96.42%

Diffuse RNFL loss was found in 34 eyes with definite visual field defect in all (100%) cases. Localized RNFL damage was present in 22 eyes, among which 20 eyes were found to have definite field loss but 2 eyes showed no VFD in automated perimetry.

DISCUSSION

Visual field assessment is an integral part of glaucoma diagnosis and management. The final assessment would still depend on the clinical judgment (evaluation of ONH) which cannot be replaced by any machine how so ever sophisticated it may be. The present study was carried out on 70 patients of glaucoma in the department of Ophthalmology, at Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly from April 2013 to April 2014. Our findings are discussed here in the light of available literature.

Age and sex distribution

The patients in the present study ranged between 24 to 79 years of age. The prevalence of POAG was highest among 51-60 yrs age group (i.e. 50.66%).

Mean age of POAG patients was 56.6 yrs which is comparable to the studies by J. Flammer *et al*⁶, and Karl U. Schmidt *et al*⁷. The prevalence was higher among males (34.66%) as compared to females (16%) in POAG, with a male female ratio = 2.16:1. Our findings regarding sex distribution of POAG are in accordance with the findings of other workers⁸⁻⁹

Base line intraocular pressure

In the present study, mean base line IOP was 28.8 in POAG cases.

The mean baseline IOP value of our series is comparable with the studies by Airaksinen & Tuulonen (1984)¹⁰, M. Schulzer *et al* (1990)¹¹, O'Brien C *et al* (1991)¹² and Weber J *et al* (1993)¹³.

Specific types of ONH features

In this series, generalized enlargement of cup in 83%, localized notch in 12.5%, disc pallor in 60%, disc hemorrhage in 12.5% and RNFL damage in 41% eyes were found.

Types of field defects

Out of 136 eyes that underwent VF testing, 48 (35.29%) eyes were found to have no field abnormality and rest 88 (64.7%) eyes had one or more forms of Visual field defects.

Localized field loss was detected in 15.44% and purely diffuse loss in 8.08% eyes. A combination of localized and diffuse field loss was found in 39.7% eyes.

Heijl A (1989)¹⁴ & Langerhorst *et al* (1989)¹⁵ showed that "entirely diffuse visual field loss almost never occurs in glaucoma" and when widespread loss is present, it is due to opacities of the media, meiosis & other artifacts.

Degree of field abnormality (Severity of field involvement)

In the present series, among the degree of field loss, severe ranked at the top with 37 (27.2%) eyes of which 24 eyes were of AVFD category. This consolidates the fact that glaucoma patients report late, until field has been severely impaired, because glaucoma involves the central vision late. It was followed by 28 (20.58%) eyes of mild defect and 15 (11.03%) eyes of moderate loss of field.

Montgomery DM (1991)¹⁶ found severe loss as the most frequent VF abnormality which is in agreement with the present study.

Relationship between age, IOP and C:D ratio with development of VFD

The present study shows a direct relationship of advanced visual field damage (AVFD) with increasing age, higher IOP level and larger cup disc ratio.

The work of Armaly *et al* (1969)¹⁷, David *et al* (1977)¹⁸, Kass *et al* (1979)¹⁹ have harmony with findings of the present series and recognized a relationship between high IOP and development of VFD.

Co-relation of ONH features with VFD

Out of 136 eyes in the present study, 7 eyes were found to have no ONH changes whereas 129 eyes had one or more features of glaucomatous optic neuropathy. Regarding VF examination, 48 eyes were found to have normal fields whereas remaining 88 eyes had various field changes. Thus, 41 eyes had ONH changes but no VF defects.

Shutt HK *et al* (1967)²⁰, Hoskins HD Jr *et al* (1975)²¹, Drance SM (1976)²², Hitchings & Spaeth (1977)²³ - structural abnormalities in the OD and RNFL precede VF abnormalities. Most cases can be diagnosed when the OD and the NFL are examined in addition to VF examination.

It is evident from the above discussion that ONH changes namely NRR notching, disc border hemorrhage and RNFL defect show a definite correlation with visual field defect. The pattern and area of VFD can be quite accurately anticipated in these three glaucomatous optic neuropathy changes. However, other ONH changes due to glaucoma may not follow any specific pattern of VF loss. It was also found that advanced glaucomatous disc damage was associated with more extensive visual field loss.

CONCLUSION

Fundus photography is valuable for determining the morphological characteristics of the optic disc, and there are significant correlations between the parameters of optic disc and MDs of HFA in all patients with glaucoma. Thus the visual field defect in the patients of primary open angle glaucoma corresponds to optic disc cupping and neuroretinal rim loss.

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