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Study of interocular asymmetry of visual field defects in Primary open angle glaucoma and Primary angle closure glaucoma

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Abstract
Aim: *To study the interocular asymmetry of visual field defects in primary open angle glaucoma and primary angle closure glaucoma*
Materials and Methods: *A hospital based, randomised, prospective, observational study of 200 eyes of 100 patients fulfilling the inclusion / exclusion criteria attending the outpatient department of Minto ophthalmic hospital from October 2013 to February 2016. Patients detailed history taken and ocular examination done, followed by static automated white on white perimetry with size III stimulus, 24 – 2 SITA standard. AGIS scores (total, superior, inferior, nasal) and global indices analysed. Comparisons between POAG and PACG were made for the mean asymmetry scores of total/nasal/superior/inferior hemifields and mean asymmetry score of individual global indices (MD and PSD).*
Results: *The mean IOP was higher in PACG group (30.06 3.5mmHg) vs POAG group (27.05 +2.5mm Hg) at the time of diagnosis. Higher mean ocular asymmetry score in global indices M.D (POAG - 1.72 ±8.6 vs PACG -4.63±9.7, p <0.0001), PSD (POAG 1.42 ± 0.16 vs PACG 2.20 ± 0.22, p<0.0001) and AGIS total score (POAG 2.23 ± 0.14 vs PACG1.4 ± 0.12, p< 0.0001), superior score(POAG 0.74 ± 0.16 vs PACG1.04 ± 0.22, p<0.0001), inferior score (POAG 0.66 ± 0.3 vs PACG1.18 ± 0.9,p<0.0001), nasal score(POAG 0.30 ± 0.06 vs PACG 0.38 ± 0.09, p = 0.5269).Correlation values also indicated higher asymmetry in PACG group.*
Conclusion: *There is greater interocular asymmetry of visual field defects as measured by AGIS and global indices in PACG than POAG.*
Keywords: *visual fields, POAG, PACG, Interocular asymmetry.*

Introduction

Glaucoma is a leading cause of irreversible blindness throughout the world and second only to cataract as the most common cause of blindness overall. Globally, Primary open angle glaucoma (POAG) affects more people than Primary angle closure glaucoma (PACG) – with an approximate ratio of 3:1, and wide variations among populations[1]. In 2013, the number of people (aged 40–80 years) with glaucoma worldwide was

estimated to be 64.3 million, increasing to 76.0 million in 2020 and 111.8 million in 2040[2]. Although glaucoma more commonly affects older adults, it occurs in all segments of the society with significant health and economic consequences.

Glaucoma diagnosis and monitoring requires assessment of structure and function of the optic nerve, and visual field analysis by perimetry is considered the gold standard for functional assessment of optic nerve[3]. Visual field studies have revealed rate of uniocular visual field loss being 2-3 times higher in cases of primary angle closure glaucoma and greater interocular asymmetry in visual field loss in patients with PACG[4,5]. This suggests a difference in the pathophysiological process of the two diseases. Theories postulate a mixed mechanism of optic nerve damage in POAG [6]. It is likely that PACG is a more pressure-dependent disease[7]. Also, documented visual field loss in one eye may prompt the physician to consider reducing the target intraocular pressure in both eyes[8].There is however a paucity of studies comparing visual field defects of both eyes of patients with open angle and primary angle closure glaucoma's [9].

This study was conducted for better understanding of the disease process and for better management of the fellow eye.

Materials and Methodology

Hospital based randomized, observational, prospective study conducted at Minto Ophthalmic Hospital, Regional Institute of Ophthalmology attached to Bangalore Medical College and Research Institute from October 2013 to February 2016.200 eyes of 100 patients fulfilling inclusion/ exclusion criteria were included into the study.

Patients with primary open angle glaucoma and primary angle closure glaucoma were included. Glaucoma was defined as intraocular pressure greater than 21mmHg with optic nerve head changes suggestive of glaucoma – CDR >0.5, loss of ISNT rule, bayonetting of vessels/ baring of circumlinear vessels / deepening of cup / laminar dot sign / presence of PPA (peripapillary atrophy) and visual field defects satisfying Andersons criteria. PACG was defined as glaucoma in the presence of an occludable angle (posterior usually pigmented trabecular meshwork was not seen over 180 degrees or more of the angle without indentation +/- PAS). POAG was defined as glaucoma in the presence of an open angle, in the absence of identifiable ocular or systemic causes. Patients with age less than 40 years, secondary glaucoma's, posterior segment pathologies that might result in a visual field defect, normotensive glaucoma's, ocular hypertensives, patients with history of uveitis were excluded from the study.

Demographic data and detailed history taken. Patients underwent detailed ocular examination that included best corrected visual acuity, subjective refraction, slit lamp Examination, applanation tonometry with Goldman's applanation tonometer, indirect gonioscopy with goldmans two mirror gonioprism and subsequent indentation gonioscopy with a 4 mirror gonioprism. Posterior segment evaluation by Indirect Ophthalmoscope and 90D lens was performed. Patients were grouped into group A (POAG) and group B (PACG).In each group then the eye with the higher IOP was labelled the "trial eye" and the other eye is designated the "fellow eye". Static, automated, white-on-white perimetry (Humphreys field analyser), with size III stimulus, 24-2, SITA standard done. Viual field done at least twice, and reliable fields analysed. Visual field defect scoring of group A - POAG and group B - PACG, using AGIS -2 and global indices done. POAG and PACG groups compared for the mean asymmetry scores of total and hemi fields with AGIS score and mean asymmetry score of individual global indices namely mean deviation (M.D) and pattern standard deviation (PSD).The mean asymmetry of AGIS scores for the entire central field as well as the superior and inferior hemi fields, and the nasal field area were calculated as the mean AGIS scores for specific regions in the trial eyes minus mean AGIS score of corresponding regions fellow eye. Likewise, the mean asymmetry scores of the global indices were

defined as the mean of MD/pattern standard deviation (PSD) in trial eyes minus the corresponding mean MD/PSD in fellow eyes. Comparisons between PACG and POAG were made for the mean asymmetry scores of total/nasal/superior/inferior hemi fields and mean asymmetry score of individual global indices.

This study was granted ethical approval by The Ethical Review Committee of Bangalore medical college, Bangalore. Verbal informed consent was obtained from all the participants in their own language with an interpreter where necessary. We followed the tenets of the Declaration of Helsinki

Data collected and analysed using appropriate statistical method using SPSS. Statistical significance was set at $p<0.05$. Parametric data analysed with frequency histograms and the one-sample Kolmogorov–Smirnov test used to assess the distribution of numerical data for parametric characteristics. Differences in mean values of parametric data between study groups were examined using an independent samples t-test. For nonparametric data, a Mann–Whitney U test was used to compare means and the Wilcoxon signed rank test for the distribution of two related variables. Spearman rank correlation r was used to measure the relationship of scores between fellow eye and trial eyes.

Results

Demographic details are summarised in table 1, with most cases belonging to the interval between 50 – 59 yrs, with ages ranging from 40 -75 yrs. However there was no significant difference in age and sex distribution between the two groups. The mean IOP at the time of presentation was higher in the PACG group (30.06 +/- 3.5mmHg), in comparison to POAG group (27.05 +/- 2.5).The difference was statistically significant.

Analysis of global indices (table 2) revealed that in POAG group there was no significant difference between the two eyes in MD ($p = 0.48$) or PSD ($p = 0.53$).On the contrary a statistically significant asymmetry existed between the two eyes in PACG group in both MD and PSD $p <0.001$.

The AGIS scores (table 3) (total, superior, inferior, nasal) showed statistically significant difference between the two eyes in both POAG and PACG group ($p<0.0001$).

The asymmetry scores for the global indices and AGIS scores of PACG and POAG are shown in Table 4. PACG has significantly greater interocular asymmetry of MD, PSD and all AGIS regions than POAG. Correlation analysis (table 5) indicates higher correlation in POAG group than PACG group in terms of global indices and AGIS scores, suggesting higher asymmetry in PACG group.

Table 1: Patient characteristics

	POAG (n = 100) MD ± SD	PACG (n = 100) MD ± SD	P value
Age (in yrs)	57.40 ± 7.79 SD	55.26 ± 6.62 SD	0.14
Male : Female	1.4 : 1	1 : 1.8	0.80305.
IOP at presentation (mm Hg)	27.05 ± 2.5	30.06 ± 3.5	<0.001

Table 2: Visual field global indices (db) by STATPAC II program for POAG and PACG

	POAG			PACG		
	Trial eye (n = 100) MD +SD	Fellow eye (n = 100) MD +SD	P value	Trial eye (n = 100) MD +SD	Fellow eye (n = 100) MD +SD	P value
Mean deviation (MD)	-7.78 ± 1.2	-7.73 ± 0.9	0.48	-7.62 ± 1.3	-5.62 ± 0.8	<0.0001
Pattern standard deviation (PSD)	5.94 ±0.38	5.63 ± 0.33	0.53	5.83± 0.29	3.92±0.17	<0.0001

Table 3: AGIS score for trial eye and fellow eye

	POAG			PACG		
AGIS score	Trial eye (n = 100) MD +SD	Fellow eye (n = 100) MD +SD	P value	Trial eye (n = 100) MD +SD	Fellow eye (n = 100) MD +SD	P value
Total	9.74 ±3.1	8.34 ± 2.36	0.005	10.04 ± 3.9	7.8 ± 1.78,	< 0.0001
Superior	4.56 ± 2.8	3.92 ± 2.4	0.0005	4.5 ± 2.6	3.78 ± 2.30	0.0065
Inferior	3.84 ± 2.76	3.3 ± 2.46	0.0134	4.12 ± 3.1	2.86 ± 1.8	<0.0001
Nasal	1.34 ± 0.64	1.12 ± 0.41	0.0163	1.36 ± 0.42	1.1 ± 0.32	0.0061

Table 4: Mean interocular asymmetry scores for POAG and PACG

	POAG	PACG	P (POAG vs PACG)
M. D	- 1.72 ± 8.6	- 4.63 ± 9.7	< 0.0001
PSD	1.42 ± 0.16	2.20 ± 0.22	< 0.0001.
AGIS total score	2.23 ± 0.14	1.4 ± 0.12	< 0.0001
Superior score	0.74 ± 0.16	1.04 ± 0.22	< 0.0001
Inferior score	0.66 ± 0.3	1.18 ± 0.9	< 0.0001
Nasal score	0.30 ± 0.06	0.38 ± 0.09	0.5269

Table 5: Interocular correlation of global indices and AGIS scores for POAG and PACG

	POAG		PACG	
	R(corelation coefficient)	p	R(corelation coefficient)	P
MD	0.7641	< 0.001	0.22	0.96
PSD	0.41	0.031	0.12	0.58
AGIS total	0.49	< 0.001	0.06	0.86
Superior	0.52	0.022	0.04	0.64
Inferior	0.36	0.041	0.02	0.62
Nasal	0.23	0.31	0.24	0.22

Discussion

In our study there was no significant difference in sex distribution in either group. However, another study by Wang et al.[4] had a predominance of male patients in the POAG group (3:1) as compared with almost equal representation in the PACG group.

In a study by Rhee et al [9], the maximum IOPs were higher in PACG group (31.9mm Hg) vs POAG group (25.1 mmHg) and the mean IOP at the time of visual fields test was higher in the POAG group (22.5 +/- 4.8 mmHg) vs PACG group (17.2 +/- 5.5 mmHg).In our study, the mean IOP at the time of diagnosis, in the PACG group was higher being 30.06 +/- 0.5, while the mean IOP in the POAG group was 27.05 +/- 0.5mmHg.Caprioli et al [10] reported that IOPs were consistently higher in eyes with diffuse field loss compared to eyes with localised field loss.

Rhee et al.[9], showed a statistically higher PSD and CPSD in POAG group than in PACG patients, suggesting that PACG patients had a more diffuse field loss than PACG patients, as a higher PSD indicates an irregular hill in the field of vision.

In our study PSD asymmetry was more in the PACG group than POAG group. Such differences between the diseases might arise if, after the onset of disease, damage progressed at markedly different rates in the two eyes, which in turn could be due to interocular asymmetries of IOP. G.Guzzard et al[8] noted a significant difference between groups in MD but not the PSD or CPSD. This is consistent with more localized defects in cases of POAG with less severe field loss.

Bonomi et al[11] used automated static perimetry and found visual field defects in 85% of cases of symptomatic primary angle-closure examined within 48 hours of the attack. Generalized defects were common, although the upper nasal quadrant was affected most frequently and more severely. One month after the symptomatic episode, 45% of subjects completed field tests graded "within normal limits."

The differences in mean asymmetry of AGIS score between PACG and POAG eyes for whole field, superior field, and inferior field scores were statistically significant despite similar age and ethnicity. Current theories postulate a mixed mechanism of optic nerve damage in POAG, with elements of pressure-sensitive and pressure-independent damage responsible for the characteristic patterns of glaucomatous optic neuropathy[6]. It is likely that PACG is a more pressure-dependent disease, said Ritch[9].There was no significant asymmetry in the nasal fields. The possible reason could be more universal vulnerability of these nerve fibre layers during early phases in each disease, or a lack of sensitivity of AGIS scoring techniques to detect subtle differences in nasal field loss[6]. In summary, we have demonstrated a difference of pattern in visual field loss between PACG and POAG.

Conclusion

There is greater interocular asymmetry of visual field loss between eyes, as measured by AGIS scores and global indices (MD and PSD), in PACG than in POAG.

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