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Original Research Article

PREVALENCE OF GLAUCOMATOUS MACULAR DAMAGE IN EARLY GLAUCOMA AND GLAUCOMA SUSPECTS MISSED WITH 24-2 VISUAL TESTING

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ABSTRACT

Background: To assess the prevalence and pattern of glaucomatous macular damage in early glaucoma and glaucoma suspects and to identify central visual field (VF) defects which were missed in 24-2 visual field testing (VFT).

Materials and Methods: This prospective observational study was conducted on 100 (168 eyes) diagnosed patients of early primary open angle glaucoma (POAG) and glaucoma suspects. First 24-2 VFT was done as baseline for defining the study groups and eyes meeting the reliability criteria were selected for further testing. On the next follow up after two weeks, 24-2 and 10-2 VFTs were performed on the same day.

Results: Out of 168 eyes, 51 tested as normal on 24-2 (30.4%) and 117 (69.6%) tested abnormal on 24-2 VFT. Of 168 eyes, 58 (34.5%) tested as normal on 10-2 and 110 (65.5%) tested abnormal on 10-2 VFT. In early POAG cases, 8 of the 16 (50%) eyes which were normal on 24-2 tests were observed to be abnormal on 10-2 VFT whereas in glaucoma suspects 9 of the 35 (25.7%) eyes normal on 24-2 tests were found to be abnormal on 10-2 VFT. Out of the 110 abnormal 10-2 VFs, 39 hemifields were having arcuate-like defects (arcuate, partial arcuate), 2 were having widespread defects (loss in all four quadrants) and the remaining 69 hemifields were having other defects. We also observed that abnormal superior hemi fields (77.3%) were more as compared to abnormal inferior hemi fields (22.7%) on 10-2 VFT.

Conclusion: The study was planned to detect early glaucomatous macular damage to become more vigilant for early detection of this sight threatening disease.

Keywords: Primary open angle glaucoma, glaucoma suspects, 24-2 and 10-2 visual field testing.

INTRODUCTION

Primary open angle glaucoma (POAG) is the second largest cause of blindness accounting for 8% of blindness among 39 million blind worldwide.[1] It is characterized by slowly progressive degeneration of retinal ganglion cells (RGC's) and their axons resulting in progressive optic neuropathy and corresponding visual field (VF) loss. A glaucoma suspect is one who has not yet developed glaucoma, but is at risk of developing it in the future. It is characterized by consistently high intraocular pressure (IOP) or abnormal optic disc or retinal nerve fibre layer (RNFL) and normal visual field test (VFT) results on standard automatic perimetry.[2]

The macula includes the region surrounding the fovea with the highest density of RGC's. It is less than 2% of the retinal area but contains over 30% of the RGC's.[3] On circumpapillary optical coherence tomography (OCT) circle scans of optic disc of patients of early glaucoma the point of maximum thinning of RFNL falls in a very narrow region called the macular vulnerability zone (MVZ) which is largely in the inferior quadrant of the disc.[4] The probability of local, arcuate retinal RNFL defects is highest in superior and inferior quadrant of the disc.[5] The most widely used 24-2 VFT pattern for detecting glaucomatous damage does not adequately test the macular region as the six degree grid of the 24-2 pattern has only four points within ± 8 degree. When

the anatomical position of the RGC's is taken into account these four, 24-2 central points are displaced such that they fall outside the region of the macula and the damage to macular fibers by glaucoma are missed.[6] Therefore, it is not surprising that the 24-2 VFT misses the glaucomatous damage of the macula that a test pattern with a two degree grid 10-2 VFT may detect.[7] Thus 10-2 visual field is the gold standard for defining macular damage.[5] To the best of our knowledge no similar study has been reported from this region and not enough data is available in the literature regarding the testing of central visual field in early glaucoma and Glaucoma Suspects. The present study was planned to assess the prevalence and pattern of glaucomatous macular damage in early glaucoma and glaucoma suspects with an ambition to highlight the need to become more vigilant for early detection of this sight threatening disease.

MATERIALS AND METHODS

The present six month prospective observational study was conducted on 100 (168 eyes) diagnosed patients of early POAG and glaucoma suspects at Regional Institute of Ophthalmology, Amritsar in 2020 after taking the ethical clearance from the institutional committee and a written informed consent from all the enrolled patients in their vernacular language in accordance with declaration of Helsinki. Both eyes of each patient were enrolled unless an eye did not meet the study criteria. We included (1) patients of both sexes and above 18 years of age (2) patients with best-corrected visual acuity (BCVA) ≥ 20/40 and refractive error<5.0 diopters sphere and <3.0 diopters cylinder between two eyes,(3) patients having open angle on gonioscopy, (4) diabetic participants without evidence of retinopathy and (5) patients having at least two reliable (<20% false positives and false negatives, and fixation losses <33%) standard automated perimetry (SAP) Humphrey 24-2 VFT results. Although 10-2 tests were not employed at baseline to define the diagnostic groups, they had to meet same reliability criteria as 24-2 tests. We excluded the patients with (1) history of intraocular surgery (except for uncomplicated cataract surgery or glaucoma surgery), (2) secondary causes of glaucoma e.g., iridocyclitis, trauma and (3) other neurological, systemic or ocular diseases known to affect the visual field.e.g. pituitary lesions, demyelinating diseases, corneal and other media opacities.

After taking detailed history, comprehensive examination including BCVA, slit lamp biomicroscopy, pachymetry with non contact specular microscope (TopconSP-3000P), gonioscopy with three mirrors Goldmann Gonio lens, IOP by applanation tonometry, dilated funduscopy examination was done. SAP with 24-2 and 10-2 Swedish interactive threshold algorithm (SITA) Standard was done and repeated after two weeks for reliable results.

Glaucoma suspects in our study were the patients having any one of the these parameters like suspicious optic disc, suspicious visual fields, positive family history of glaucoma whereas early POAG patients were defined as having any two of these parameters like glaucomatous optic neuropathy, IOP >21mmHg and visual fields suggestive of glaucoma.

24-2 VFT of early POAG and glaucoma suspects was done. First 24-2 visual field was done as baseline for defining the study groups and eyes meeting the reliability criteria, with mean deviation (MD) better than -6 dB were selected for further testing. Next follow up was done after two weeks, in which 24-2 and 10-2 VFTs were performed on the same day. 24-2 VFT was considered abnormal if there was cluster of three non edge contiguous points (p<5%, 5%, 1% OR 5%, 2%, 2%) within a hemifield on pattern deviation. Nature of 10-2 visual field defects were assessed using a cluster rule. A cluster of three contiguous points (p<5%, 5%, 1% OR 5%, 2%, 2%) within a hemifield on pattern deviation was defined as abnormal. Based on pattern/shape of abnormal points, the visual field hemifields were further classified in three categories, arcuate like (arcuate, partial arcuate), widespread or other.

The arcuate like defect included a defect which was continuous, dense and in both quadrants in a hemisphere. Partial arcuate were also a continuous defect that involves both quadrants in a hemisphere but less dense than an arcuate. Widespread defect was defined as a loss in all four quadrants (cluster of three contiguous points i.e p<5%, 5%, 1% OR 5%, 2%, 2%) on both total and pattern deviation plots. Whereas abnormal hemifields that did not fall into either criteria and mostly scattered predominantly in the temporal and nasal quadrants were classified as other. 10-2 visual fields were also classified on the basis of defects in superior and inferior hemifields.

Statistical analysis used: The categorical variables were reported as count and percentage while continuous variables as mean± standard deviation (SD).Student T test and Chi square test was used. P value less than 0.05 was considered as statistical significant. All data was compiled and analysis was done with IBM SPSS Statistics for Windows (Version 23.0 IBM corp.)

RESULTS

Out of 100 patients of early POAG and glaucoma suspects, 51% were males and 49.0% were females, 83% patients had no family history of glaucoma and 17% patients had family history of glaucoma, 22% patients had diabetes, 18% patients had hypertension, 2% patients had both diabetes and hypertension, 4% patients had history of migraine and 54% patients had no history of any systemic disease.

Out of 168 eyes, 50% (84 eyes) of eyes had best corrected visual acuity BCVA of 6/6, 25.6% (43) of eyes had BCVA of 6/9 and 24.4% (41) eyes had

BCVA of 6/12. Other factors in glaucoma suspects and early POAG patients are as follows. [Table 1]

Table 1: Showing other factors in Glaucoma suspects and early POAG patients

	Glaucoma Suspects	POAG	P value
Number of eyes affected	46 (27.4%)	122 (72.66%)	
Mean age	48.97±9.75	52.59±11.43	<0.05
Mean IOP	20.30±2.26	25.25±2.20	<0.001
Mean CCT	460.65±0.02	469.38±0.77	>0.05
Mean VCDR	0.50±0.11	0.59±0.12	<0.001

IOP= intraocular pressure, CCT=central corneal thickness, VCDR= vertical cup disc ratio

Among 168 eyes, 51 (30.4%) were tested normal on 24-2 VFT and 58 (34.5%) on 10-2 VFT while 117 eyes (69.6%) were tested abnormal on 24-2 VFT and 110 (65.5%) on 10-2 VFT.

Out of 46 eyes of glaucoma suspects, on 24-2 VFT, 35 eyes (76.1%) were normal whereas 11 eyes (23.9%) were abnormal. On 10-2 VFT, 28 eyes (60.9%) were normal and 18 eyes (39.1) were abnormal. So 9 of the 35 (25.7%) eyes which were normal on 24-2 tests were observed to be abnormal on 10-2 tests. Out of 122 eyes of early POAG, on 24-2 VFT, 16 eyes (13.1%) were normal whereas 106 eyes (86.9%) were abnormal. On 10-2 VFT, 30 eyes (24.6%) were normal and 92 eyes (75.4) were abnormal. So 8 of the 16 (50%) eyes which were normal on 24-2 tests were observed to be abnormal on 10-2 tests. [Table 2]

Table 2: Showing comparison between 24-2 and 10-2 VFT in glaucoma suspects and in early POAG

24-2 VFT	10-2 VFT					
	In glaucoma suspects			In early POAG		
	Normal	Abnormal	Total	Normal	Abnormal	Total
Normal (No. of eyes)	26 (74.3%)	09 (25.7%)	35	08 (50.0%)	08 (50.0%)	16
Abnormal (No. of eyes)	02 (18.2%)	09 (81.8%)	11	22 (20.8%)	84 (79.2%)	106
Total	28	18	46	30	92	122

VFT= visual field testing

In glaucoma suspects, we found more number of normal eyes (76.1%) on 24-2VFT and (60.9%) on 10-2 VFT, as compared to the abnormal eyes whereas In early open angle glaucoma, we found more number of abnormal eyes (86.9%) on 24-2VFT and (75.4%) on 10-2 VFT, as compared to the normal eyes

Out of 168 eyes, 110 eyes which were abnormal on 10-2 tests were classified on the basis of nature of their defect in the hemifield, it was observed that 11(10%) eyes had arcuate defect, 20(18.1%) eyes had nasal defect, 28(25.5%) had partial arcuate defect, 2(1.9%) eyes had widespread defect and 49(44.5%) eyes were classified under others defects. [Table 3]

Table 3: Showing nature of visual field defect on 10-2 VFT

Nature of Visual field defects on 10-2 VFT			Number of eyes	% age
Abnormal Visual fields	Arcuate like	Arcuate	11	53.6
		Nasal Defect	20	
		Partial Arcuate	28	
	Others		49	44.5
	Widespread		02	1.9
	Total		110	

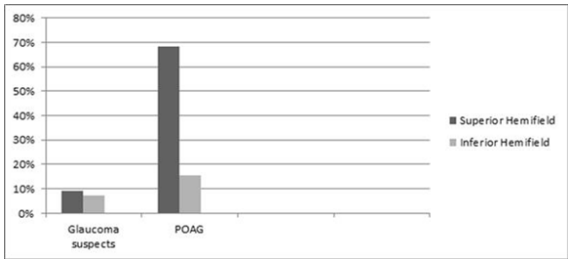

Figure 1: Comparison between superior and inferior hemifields defects in Glaucoma suspects and POAG cases

We observed that, in glaucoma suspects (18 eyes), 10 eyes (9%) had superior hemifield defect and 8 eyes (7.3%) had inferior hemifield defect whereas in POAG (92 eyes), 75 eyes (68.2%) had superior hemifield defect and 17 eyes (15.5%) had inferior hemifield defect. [Figure 1]

DISCUSSION

Involvement of central vision in glaucoma is a major risk factor for blindness. Though it is generally believed that central field is preserved till advanced stage of glaucoma,[8] but structural and functional damage in the macula has been identified even in early glaucoma.[5] Central vision which correlates with macular function is important while performing routine life activities. Quality of vision is hampered once these central defects appear in early glaucoma. Thus to recognize and understand the difficulties confronted by early POAG patients and glaucoma

suspects who otherwise appear to be normal and to clinch the diagnosis at an early stage to decrease the economical and psychological burden on the society, it is important to screen them early for central defects. Of 168 eyes, 51 tested as normal on 24-2 (30.4%) and 117 (69.6%) tested abnormal on 24-2 VFT. Out of 168 eyes, 58 (34.5%) tested as normal on 10-2 and 110 (65.5%) tested abnormal on 10-2 VFT. In early POAG cases,8 of the 16 (50%) eyes which were normal on 24-2 tests were observed to be abnormal on 10-2 tests [Table 3] whereas in glaucoma suspects 9 of the 35 (25.7%) eyes normal on 24-2 tests were abnormal on 10-2 visual fields [Table 2].

It was in accordance with a study done by De Moraes et al in 2017 who also found that 16 of the 26 (61.5%) eyes of early POAG classified as normal based upon cluster criteria on 24-2 tests were classified as abnormal on 10-2 visual fields and in eyes with suspected glaucoma, 79 of the 200 (39.5%) eyes classified as normal on 24-2 were classified as abnormal on 10-2 visual fields.[9] Hood et al and Heijl et al also confirmed that glaucomatous VF damage usually commences in the central VF.[5,10]

Similar findings were reported in another study done in 2014 which revealed that the 16% of their eyes with normal 24-2 hemifields had abnormal VFT when the 10-2 test was used.[11]

A comparative study done by Schiefer et al. in 2003 has shown that VF defects are better detected in glaucoma suspects when closely spaced points were used.[12] Similar findings were concluded by Sullivan Mee et al and Park HY et al that 24-2 VFT missed central defects that were detected on 10-2 VFT.[13,14] These observations signify the importance of 10-2 VFT in glaucoma suspects and early POAG.

To better understand the nature of early macular damage due to glaucoma, we identified the pattern of damage and classified the visual field defects seen on 10-2 VFs. We found that out of the 110 abnormal VFs on 10-2 hemifields, 59 hemifields were having arcuate-like defects, 2 hemifields were having widespread defects and the remaining 49 abnormal hemifields, were having other defects. Similar findings were found in another study in which on 10-2 VFT 68% had arcuate-like, 8% widespread 25% other visual defects.[11]

We also observed that abnormal superior hemi fields (77.3%) were more as compared to abnormal inferior hemi fields (22.7%) on 10-2 VFT. Similarly Traynis I et al in his study in 2014 concluded that superior hemifields (59%) were more abnormal than inferior hemifields (47%) on 10-2 VFs.[11]

Hood et al and Heijl et al also reported that glaucomatous visual field damage commences particularly in the superior hemifield of central visual field.It corresponded to flow of RFNL into the optic disc at the infero-temporal angle.[5,10] Schiefer et al. also reported that Glaucomatous visual field defects were observed more frequently in the upper than in the lower hemifield, more so (50%) in superior paracentral region.[15]

Limitations: There were a few limitations in our study. Firstly the sample size in our study was small. Secondly first two 24-2 VFTs in both glaucoma suspects and POAG were not considered to account for the learning curve and subsequent two visual field examinations (24-2 and 10-2 SITA standard) were performed on the same visit considering the test being psychophysical in nature relies on patient education and as well as mindful concentration, on part of the patient, to produce reliable results which may not be possible in the same sitting. Still considering these limitations the visual fields were analyzed in a systematic manner to the best of our ability.

CONCLUSION

10-2 VFT detects central visual field defects which may have been missed in 24-2 testing not only in early glaucoma but also in glaucoma suspects. Thus 10-2 VFT done at the outset would not only avoid delay in diagnosis of glaucoma but also precisely assess the severity of glaucoma. The place of 24-2 C protocol needs to be incorporated for early glaucoma - central visual field loss detection. It will further help to discern the impairment in quality of life of an individual in performing day to day activities who otherwise has mild disease.

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