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Early Glaucomatous Defects in The Central 10° of the Visual Field

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ABSTRACT

Background: The early detection of glaucoma is imperative for functional vision preservation. Utilizing both structural measurements and functional assessments together improve the capability of glaucoma detection. New testing methods are continuously developed with the goal of earlier disease detection and improvement of disease monitoring. **Aim of the work:** In our study we have attempted to detect early glaucomatous defects in the central 10° of the visual field. **Material and methods:** This prospective study was carried out on 30 eyes with mild to moderate glaucomatous optic neuropathy. All patients were with POAG patients, all of them with glaucomatous optic neuropathy on fundus examination (Humphrey Visual Field Analyzer; Carl Zeiss Meditec Inc) Only eyes with reliable 24-2 and 10-2 VFs, defined as fixation losses of 33% or less, false positives of 15% or less, and false negatives of 20% or less. **Results:** There was a positive significant correlation between 24-2 and 10-2 at diagnosis of central scotoma and No significant scotoma but there was no significant correlation between 24-2 and 10-2 at diagnosis of other focal defect. **Conclusion:** 10-2 was a good tool to diagnosis of early glaucoma when compared with 24-2 with high significant especially with diagnosis of central scotoma and no significant scotoma (p=0.016) and (p=0.031) respectively.

Keywords: Early glaucoma, POAG, Central 10°, Focal defect.

1. Introduction

Glaucoma affects I-2% of people over 40 years old in western developed countries and accounts for 8 - 15% of new registrations for blindness. Glaucoma is defined in terms of glaucomatous optic nerve damage, which is exhibited by characteristic visual field defects and associated abnormalities of the optic disc (Zhao *et al.,* 2019).

Some forms of the disease are symptomatic, but the most common (about 80% of cases) is primary open angle glaucoma (POAG), a chronic condition of which the sufferer is typically unaware until much sight has been irreversibly lost (Singh and Rijal, 2020). Primary openangle glaucoma is a progressive chronic optic neuropathy, typically bilateral. It is a worldwide leading cause of irreversible blindness. Primary open-angle glaucoma corresponds to a progressive loss of retinal ganglion cells characterized by an excavation of the optic disc associated with typical visual field defects (Gedde *et al.,* 2021).

The visual functions most vital for some everyday activities, such as reading and object identification, depend on the integrity of the fovea and the central macular region immediately around it. However, the test pattern most widely used in static automated perimetry does not adequately sample the macular region. In particular, the points of the 242 visual field (VF) test pattern are spaced every 6°. Thus, only 4 points fall within the central 8°, the region in which more than 30% of the retinal ganglion cells (RGCs) reside (Maniglia *et al.,* 2020). Furthermore, on fd OCT scans, the RGC region within the central 4 points of the 24-2 test was thinner than normal, even in glaucoma suspects with VFs judged to be normal (Muhammad *et al.,* 2017).

Practically speaking, the fact that early glaucomatous damage can occur close to fixation would

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not matter if the 24-2 (6° grid) test did as well as the 10-2 (2° grid) test in detecting early macular damage. However, to our knowledge, there is surprisingly little information on this important point (Hood *et al.,* 2021).

In a largely overlooked study, Langerhorst *et al.* (1997) prospectively obtained VF data with both a 30-2 (6° grid) and a 10-2 (2° grid) test pattern. For their patients, who were either glaucoma suspects or showed signs of early glaucoma, 9% of the hemifields classified as normal with the 30-2 were classified as abnormal with the 10-2.

Furthermore DeMoraes *et al.* (2017) the 30-2 test underestimated the severity of glaucomatous damage in 13% of the hemifields. Because of the clinical importance of central vision, more information is needed regarding possible macular damage missed with a 6° (30-2 and 24-2) test grid.

Aim of the study

The aim of this study is detecting the early glaucomatous defects in the central 10° of the visual field.

Patients and Methods

The study was done at ophthalmology department, Tanta university hospitals, during the period from June 2021 to June 2022. Study Population: The study included 30 eyes with mild to moderate glaucomatous optic neuropathy.

Study Design:

Prospective, cross-sectional study.

The Inclusion criteria: Patients with mild or moderate POAG. Patients with glaucomatous optic neuropathy on fundus examination by slit lamp biomicroscopy. Only eyes with reliable 24-2 and 10-2 VFs, defined as fixation losses of 33% or less, false positives of 15% or less, and false negatives of 20% or less are included.

The Exclusion Criteria: Angle closure glaucoma. All types of secondary glaucomas. Congenial glaucoma. Any Previous ocular surgeries. Patients with opaque media. Other ocular pathology associated with other visual field changes.

All patients in this study were subjected to the following: History Taking: Including age, sex, previous and present ocular or systemic diseases, previous ocular trauma, previous ocular surgery. Full examination was done to all patients after taking full history. A comprehensive adult eye examination included Visual acuity measurement. Preliminary tests of visual function and eye health, including depth perception, color vision, peripheral (side) vision and the response of the pupils to light was done for all patients.

Examination of eye movements, cornea, lens, conjunctiva was done for all patients. Examination of fundus and optic nerve was done by slit lamp biomicroscopy using volk 90 lens. Gonioscopy by Goldman three mirrors was done. Measurement of intraocular pressure by Goldman applanation tonometry was done. Visual field test was done by Humphrey® Field Analyzer 3 (HFA3). Both 10-2 and 24-2 VFs used the same test spot size (Goldmann size 3) and were obtained with the SITA [Swedish interactive thresholding algorithm]-standard test strategy after appropriate refractive correction. Classifying 10-2 Visual Fields: The VFs of the 30 eyes were classified using a cluster rule. Specifically, hemifields were classified as abnormal if there was cluster of 3 contiguous points (5%, 5%, and 1% or 5%, 2%, and 2%) within a hemifield on either total deviation (TD) or pattern deviation plots. Additional 10-2 Analyses of the Pattern of Early Glaucomatous Visual Field Damage.

At each point of the 10-2 VF, the TD values were averaged across all 30 eyes.

In addition, the number of abnormal points with TD values below a criterion level of −3, −5,

−15, or −20 dB was calculated**.**

3. Results

Table 1: Demographic data for 30 studied eyes

	No.	%
Sex: Male	25	83.3
Female	5	16.7
Age (years): 41 - 60	17	56.6
>60	13	43.3
Min. - Max.	41.0 - 71.0	
Mean ± SD.	56.80 ± 11.17	
Median (IQR)	60.0 (54.0 - 65.0)	

Table 2: Descriptive analysis of the studied eyes according to fundus examination and refraction

	Min. - Max.	Mean ± SD.	Median (IQR)
C/D	0.20 - 0.60	0.39 ± 0.14	0.40(0.30 - 0.50)
Refraction SE	-0.5 - 1.75	-1.58 ± 2.16	-1.50(-3.50 - 0.75)

Table 3: Distribution of the studied eyes according to visual acuity

Visual acuity	No.	%
Snellen		
6/6	10	33.3
6/9	8	26.7
6/12	12	40.0
Decimel		
Min. - Max.	0.50	- 1.0
Mean ± SD.	0.71 ± 0.22	
Median (IQR)	0.67 (0.50 - 1.0)	
Logmar		
Min. - Max.	0.0 -	0.30
Mean ± SD.	0.17 ± 0.1 3	
Median (IQR)	0.18 (0.0 - 0.30)	

Table 4: Comparison between 24-2 and 10- 2 according to MD

MD	24-2	10-2	Z	P
Min. - Max.	0.42 - -10.16	0.33 - -6.60		
Mean ± SD. Median	4.07 ± 3.19	3.62 ± 1.82	0.360	0.719 (NS)
Median (IQR)	2.75(-5.23 - -1.99)	3.77(-4.69 - -2.01)		

Table 5: Comparison between 24-2 and 10- 2 according to PSD

PSD	24-2	10-2	Z	P
Min. - Max.	1.17 - 9.30	0.89 - 1.89		
Mean ± SD. Median	2.95 ± 2.17	1.36 ± 0.29	4.416*	<0.001* (HS)
Median (IQR)	1.87(1.43 - 5.10)	1.41(1.10 - 1.61)		

Table 6: Comparison between 24-2 and 10-2 according to Focal defect

Focal defect	24-2		10-2		P
	No.	%	No.	%	
No significant scotoma	14	46.7	20	66.7	0.031*
Advanced diffuse scotoma	1	3.3	0	0.0	1.000
Diffuse scotoma	1	3.3	0	0.0	1.000
Inf nasal scotoma	1	3.3	0	0.0	1.000
Infparacentralscotoma	2	6.7	1	3.3	1.000
Inf temporal paracentralscotoma	1	3.3	0	0.0	1.000
Inferior temporal scotoma	1	3.3	0	0.0	1.000
Paracentralscotoma	1	3.3	1	3.3	1.000
Sup nasal scotoma	7	23.3	0	0.0	1.000
Central scotoma	0	0.0	4	13.3	0.016*
Sup paracentralscotoma	0	0.0	2	6.7	0.125
Sup&inf nasal scotoma	1	3.3	0	0.0	0.500
Sup &inf temporal Paracentralscotoma	0	0.0	2	6.7	1.000

4. Discussion

Glaucoma is the leading cause of irreversible blindness globally which significantly affects the quality of life and has a substantial economic impact (Wu *et al.,* 2022).

Effective detective methods are necessary to identify glaucoma as early as possible. Regular eye examinations are important for detecting the disease early and preventing deterioration of vision and quality of life. Current methods of measuring disease activity are powerful in describing the functional and structural changes in glaucomatous eyes. However, there is still a need for a novel tool to detect glaucoma earlier and more accurately (Wu *et al.,* 2022).

New testing methods are continuously developed with the goal of earlier disease detection and improvement of disease monitoring (Lucy and Wollstein, 2016).

The fact that early glaucomatous damage can occur close to fixation would not matter if the 24-2 (6° grid) test did as well as the 10-2 (2°grid) test in detecting early macular damage. However, to our knowledge, there is surprisingly little information on this important point (Hood *et al.,* 2021).

The study was carried out at ophthalmology department, Tanta university hospitals, during the period from June 2021 to June 2022. The study included 30 eyes with mild to moderate

optic neuropathy.

The aim of the current study was to detect the early glaucomatous defects in the central 10° of the visual field.

All patients were POAG patients and with glaucomatous optic neuropathy on fundus examination, reliable 24-2 and 10-2 VFs, defined as fixation losses of 33% or less, false positives of 15% or less, and false negatives of 20% or less (Humphrey Visual Field Analyzer; Carl Zeiss Meditec Inc).

The study of Roberti *et al.* (2017), which was done on 43 patients also found that about (51%) were male that showed no sexual predisposition for POAG.

The study of Roberti *et al.* (2017), was not in agreement with the present study, who found that patients with POAG were older than patients in present study, as the mean of age was (65.2± 10.1).

In the present study the average mean of C/D ratio of 30 eyes with POAG was (0.39 ± 0.14). This result agrees with Elgin *et al.* (2018), who found the mean of C/D ratio in mild to moderate POAG patients was (0.37± 0.12).

Regarding the measurement of refraction SE for 30 patients with POAG, the mean was (-1.58 ± 2.16). This result is supported by Elgin *et al.* (2018) (13), who found the mean of refraction SE for POAG patients was (-1.94 ± 1.86).

In the present study, V.A. measurement in 30 patients with POAG was represented by 10 eyes (33.3%) 6/6, 8 eyes (26.7%) was 6/9 and 12 eyes (40%) was 6/12. These results do not

agree with Awoyesuku and Ejimadu (2012), who found V.A. for POAG patients showed that (16.4%) was 6/6, (39.6%) was 6/9 and (44%) was 6/18.

The present study revealed a statistically non-significant difference in the mean MD (p=0.71) between 24-2 and 10-2 in patients with POAG, the mean MD of 24-2 (-4.07 ± 3.19) and in 10-2 (-3.62 ± 1.82). This agrees with Orbach *et al.* (2021). Who found the mean MD of 24-2 was (−4.98 ± 0.09) and in 10-2 was (−4.42 ± 0.25), with statistically nonsignificant difference.

In the study of Jung *et al.* (2021), who found the mean MD of 24-2 was (-2.3±1.7) and in 10-2 was (-4.6±3.1) with statistical significant (p<0.001), and this result does not agree with present study.

Regarding to PSD in the present study, there was high statistically significant difference (p=0.001) in the mean PSD between 24-2 and 10-2, the mean PSD of 24-2 was (2.95 ± 2.17) and the mean 10-2 PDS was (1.36 ± 0.29).

This result is in agreement with Jung *et al.* (2021), who showed statistical significant result (p<0.001) in the mean PSD between 24-2 and 10-2.

In the study of Orbach *et al.* (2021), the result does not agree with the present study, as the mean PSD of 24- 2 was (1.67±6.20) and for 10-2 was (0.79± 3.64) which is statistically non significant (p =0.07).

Regarding to focal defects in the present study, there was statistically significant difference between 24-2 and 10-2 at diagnosis of (central scotoma and no significant scotoma), it was so clear that 10-2 has role in early detection of glaucoma as it could diagnose central scotoma at 4 eyes (13.3%) which is statistically significant (P=0.016).

According to no significant scotoma, it was so clear that 10-2 has role in early detection of glaucoma as it could diagnose it at 20 eyes (66.7%) which is statistically significant (P=0.031).

Regarding to the role of 10-2 VFs in detecting central damage of POAG, in the study of Jung *et al.* (2021), who studied 200 patients in whom there were 79 (39.5%) classified as central scotoma on 10-2 VFs were classified as normal on 24-2 VFs. This result is in agreement with the present study.

In agreement with the result of the present study, the study of Roberti *et al.* (2017), who studied 41 POAG eyes, in whom there were 33 (80.4%) detected as central damage by 10-2 and were normal by 24-2.

In the study of Traynis *et al.* (2014), who studied 22 POAG eyes, there were 5 eyes (22.7%) detected as central damage by 10-2 and were normal by 24-2, and this result agrees with the result of the present study in showing the role of 10-2 in diagnosis of early glaucoma than 24-2.

In the study of Singh and Rijal (2020), who found (88%) of the eyes showing agreement on the 24-2 and 10-2, and (20.5%) of the 24-2 classified as abnormal were found to be normal on the 10-2 test, which does not agree with the result of the present study.

In agreement with the present study, Kathleen *et al.* (2021) found that 10-2 detected more points of deficit compared to the 24-2 specially in central damage of early POAG and was statistically significant(p<0.0001).

On the other hand, according to the study of Michael *et al.* (2020), who found glaucoma patients with early damage with the 24-2 test, and 10-2 test could not add any role in detecting defects in the central visual field, as the 24-2 and 10-2 tests were not statistically significant. This result was not in agreement with the result of the present study.

Also in the study of West *et al.* (2021), whose result was not in agreement with the result of the present study, as it was the fact that 10-2 does not offer diagnostic advantage when compared with 24-2.

According to an exciting study of Danica *et al.* (2021). Who had used a new tool to detecting early glaucoma with 24-2C program. This is a new test pattern on the HFA that adds 10 test points within the central 10º to the 24-2 test grid (five in the superior and five in the inferior hemifield) this program adds the advantage of 10-2 to 24-2. Test points were chosen by an expert group and were based on areas known to be susceptible to glaucoma damage from structural and functional studies. Not surprisingly, the 24-2C has been shown to identify more central defects and have better structure function correlation than the 24-2.

On the other hand, in the present study, there was no role to 10-2 VFs in diagnosis of other focal defect which are (advanced diffuse scotoma, diffuse scotoma, inf. nasal scotoma, inf. temporal paracentral scotoma, inferior temporal scotoma, sup. & inf nasal scotoma) 3.3% detected abnormal by 24-2VFs for each type, were normal by 10-2VFs. this was statistically non-significant. (Inf. paracentral scotoma) was 6.7% detected abnormal in 24.2, was 3.3% normal by 10-2 which was statistically nonsignificant. (Sup. nasal scotoma) was 23.7% detected by 24-2 VFs and was normal by 10-2 VFs. This result was in agreement with the study of Singh and Rijal, (2020), who found no role for 10-2 to detect all these focal defects as such as central defects.

Also in the study of Chakravarti *et al.* (2021), there were an agreement between 24-2 and 10-2 in detecting central and peripheral focal defects with no benefit role of 10-2 over 24-2.

Conclusion:

10-2 VFs was statistically significant in diagnosis of non-significant scotoma (66%). 10-2 VFs was statistically significant in diagnosis of central scotoma (13.3%). It is so clear that 10-2 has role in diagnosis of central damage, so it can be employed as a test for early detection of glaucoma. there was no significant value when comparing between 24-2 and 10-2 for diagnosis of other focal defect which are advanced diffuse scotoma, diffuse scotoma, inf. nasal scotoma, inf. paracentral scotoma, inf. temporal paracentralscotoma, inferior temporal scotoma, paracentral scotoma, sup nasal scotoma, sup paracentral scotoma, sup & inf nasal scotoma, sup & inf temporal paracentral scotoma.

References

Awoyesuku, E. A. and C. S. Ejimadu, 2012. Visual disability in newly diagnosed primary open angle glaucoma (POAG) patients in a tertiary hospital in Nigeria. Nigerian Journal of Medicine 21.1 78-80.

Chakravarti, T., M. Moghadam, et al., 2021. Agreement Between 10-2 and 24- 2C Visual Field Test Protocols for Detecting Glaucomatous Central Visual Field Defects. Journal of Glaucoma, 30, 6, 23 June, pp. e285-e291(7).

Danica, M. OD., et al., 2021. Breaking Down Visual Fields in Glaucoma. Review of optometry, Feb 15, leadership in clin. Care.

De Moraes, C., D. Hood and A. Thenappan, , 2017. 24-2 visual fields miss central defects shown on 10-2 tests in glaucoma suspects, ocular hypertensives, and early glaucoma. Ophthalmology, 124(10), 1449-1456.

Elgin U., E. Şen, M. Uze and P Yılmazbaş, 2018. Comparison of Refractive Status and Anterior Segment Parameters of Juvenile Open-Angle Glaucoma and Normal Subjects. Turk J Ophthalmol., 48(6):295- 298. doi:10.4274/tjo.68915

Gedde, S., K. Vinod and M. Wright, 2021. Primary Open-Angle Glaucoma Preferred Practice Pattern®. Ophthalmology. 128(1), P71-P150.

Hood, D., A. Thenappan and E. Tsamis, 2021. An Evaluation of a New 24-2 Metric for Detecting Early Central Glaucomatous Damage. American Journal of Ophthalmology, 223, 119-128.

Jung, K.I., H.K. Ryu, K.H Hong et al., 2021. Simultaneously performed combined 24-2 and 10-2 visual field tests in glaucoma. Sci Rep., 11, 1227.

Kathleen, F., O. Freeman *et al.,* 2021. 10-2 and 24-2C Test Grids for Identifying Central Visual Field Defects. Published in Eye Care Journal Scan.

Langerhorst, C.T., L.L. Carenini and D. Bakker, 1997. Measurements for description of very early glaucomatous field defects. In: Wall M, Heiji A, eds. Perimetry Update 1996/1997. New York, NY: Kugler Publications.67-73.

Lucy, K. A. and G. Wollstein, 2016. Structural and functional evaluations for the early detection of glaucoma." Expert review of ophthalmology, 11.5 367-376.

Maniglia, M., V. Soler and Y. Trotter, 2020. Combining fixation and lateral masking training enhances perceptual learning effects in patients with macular degeneration. Journal of Vision, 20(10), 19-19.

Michael, E., M. Doona, et al., 2020. Value of 10-2 Visual Field Testing in Glaucoma Patients with Early 24-2 Visual Field Loss. American academy of ophthalmology, 128, (4), P545-553.

Muhammad, H., T. Fuchs and N. De Cuir, 2017. Hybrid deep learning on single wide-field optical coherence tomography scans accurately classifies glaucoma suspects. Journal of glaucoma, 26(12), 1086.

Orbach, A., G. S. Ang, A.S. Camp et al., 2021. Qualitative Evaluation of the 10-2 and 24-2 Visual Field Tests for Detecting Central Visual Field Abnormalities in Glaucoma. Am J Ophthalmol, 229: 26-33.

Roberti, G., G. Manni, I. Riva et al., 2017. Detection of central visual field defects in early glaucomatous eyes: Comparison of Humphrey and Octopus perimetry." PloS one 12.10 e0186793.

Singh, P., and A. P. Rijal, 2020. Pattern of Visual Field Defects in Newly Diagnosed Primary Open Angle Glaucoma Patients Attending Tertiary Care Hospital, Kathmandu, Nepal. Nepal Medical College Journal. 22(4), 203-210.

Traynis, I., C.G. De Moraes, et al., 2014. Prevalence and nature of early glaucomatous defects in the central 10° of the visual field. JAMA Ophthalmol., 132(3):291-297.

West, M., G. Sharpe, D. Hutchison, et al., 2021. 10-2 testing offers limited benefit over 24-2 testing in patients with POAG.

Wu, Y., M. Szymanska, Yubing Hu et al., 2022. Measures of disease activity in glaucoma." Biosensors and Bioelectronics, 196, 113700.

Zhao, J., M. Solano and C. Oldenburg, 2019. Prevalence of normal-tension glaucoma in the Chinese population: A systematic review and meta-analysis. American journal of ophthalmology. 199, 101-110. 2.