ECRONICON OPEN ACCESS

EC OPHTHALMOLOGY
Research Article

Correlation between FDT Matrix and OCT (RTVue) in Glaucoma Suspects

María Eugenia Gilbert-Lucido[1], Magdalena García-Huerta[1]*, Francisca Domínguez-Dueñas[1] and Gabriela Berumen-Alatorre[2]

[1]Glaucoma Clinic, Sanatorio Oftalmológico Mérida, México

[2]Clínica Berumen, Ciudad Juárez, Chihuahua, Mexico

***Corresponding Author:** Magdalena García-Huerta, Glaucoma Clinic, Sanatorio Oftalmológico Mérida, México.

Received: June 13, 2020; **Published:** July 31, 2020

Abstract

Introduction: The functional evaluation for glaucoma detection with frequency doubling technology (MATRIX) has a good sensitivity and specificity. The optical coherence tomography (OCT) provides relatively direct measurements of the neuroretinal rim, retinal fiber layer and macular ganglion cell complex.

Purpose of the Study: The purpose of this study is to determine the structure-function relationships between the MATRIX and OCT (Optovue) parameters.

Methods: This is a cross-sectional study that included 40 eyes from 22 glaucoma suspects. We evaluated the correlations between the parameters of ganglion cell complex (GCC), retinal nerve fiber layer (RNFL) measured with Optovue (OCT) and the visual field sensitivity and global index of the FDT MATRIX.

Results: We founded stronger correlations between the ganglion cell complex with the global index and between the RNFL and the visual field sensitivity in the overall measurements.

Conclusion: The structure-function correlation between the MATRIX and OCT Optovue is useful for the glaucoma diagnostic.

Keywords: *Retinal Ganglion Cells (RGC); Retinal Nerve Fiber Layer (RNFL); Optovue (OCT)*

Introduction

Glaucoma is the second cause of blindness in the world [1,2]. It is a neurodegenerative disease characterized by progressive retinal ganglion cells (RGC) loss associated with structural changes in the optic nerve head and in the retinal nerve fiber layer (RNFL) [3]. Individuals with glaucoma are usually asymptomatic since more than half of the patients, even in developed countries, are undiagnosed, even in developed countries [4].

Because Glaucoma results in visual impairment, early diagnosis is crucial. The most functional evaluation is performed using primarily with visual field tests. The Humphrey Visual Field Analyzer Standard Automated Perimeter (SAP) is one of the most widely used devices in clinical studies, but it can only diagnose glaucomatous vision loss after more than 40% of the nerve tissue is irreversibly lost [5,6]. Many studies have demonstrated that the Frequency Doubling Technology Matrix (FDT Matrix) has a good sensitivity and specificity for the detection of glaucoma. This device provides visual field measurements using stimuli consisting of alternate sinusoidal codes at low spatial and high temporal frequency [7,8].

The evaluation of the Optic Nerve Head (ONH) and the RNFL is fundamental for early diagnosis. Besides the clinical examination, computerized imaging methods, such as the Optical Coherence Tomography (OCT), provide relative direct measurements of the neuroretinal rim, the RNFL and the macular Ganglion Cell Complex (GCC) [9,10]. Different studies have demonstrated that the RTVue measures of the RNFL and the inner macular thickness are the best ones to discriminate between a normal and a glaucoma patient [11-13].

Purpose of the Study

The purpose of this study is to determine the structure-function relationship between the FDT Matrix and the OCT RTVue in glaucoma patients, glaucoma suspects and health control.

Methods

Healthy people, primary open-angle glaucoma individuals and glaucoma suspects were enrolled in this observational, transversal, cross-sectional, prospective and comparative study.

All the procedures were attached to the recommendations of the Declaration of Helsinki and all participants gave their consent prior to any testing, clinical examination, or collection of demographic or medical information.

All participants underwent through a complete ophthalmic examination, including best-corrected visual acuity measurement, slit-lamp biomicroscopy, Goldmann tonometry, gonioscopy, and dilated fundus examination. The instruments used were the following: 24-2 Sita Standard SAP (Humphrey Visual Field Analyzer, Carl Zeiss Meditec, Dublin, CA, USA), 24-2 FDT Matrix (Carl Zeiss Meditec perimetries) and OCT RTVue-100 FD-OCT (Optovue Inc., Fremont, CA, USA).

The inclusion criteria were: visual acuity of at least 20/40; refractive error between +-6.00 spherical diopters and +-3.00 cylindrical diopters; previous experience with SAP and FDT Matrix in at least two exams having reliable results; and absence of ocular surgeries, macular or vitreoretinal disease, neurological disease or dense cataract that could interfere with the exams.

All healthy individuals went through a complete ophthalmologic examination, had an intraocular pressure (IOP) less than 21 mmHg (having no history of elevated IOP), went through the SAP and FDT Matrix with Glaucoma Hemifield Test (GHT) within normal limits, and went through the OCT RTVue within normal limits too.

On the other hand, glaucoma patients had a history of elevated IOP, open-angle, signs of optic neuropathy and an abnormal 24-2 SAP, GHT and OCT RTVue.

Finally, glaucoma suspects had a relative with glaucoma, an asymmetric cup-to disc ratio or an optic disc cup higher than 6/10 with abnormal appearance and an SAP within normal limits.

Statistical analysis

Mean and standard deviation were used to describe continuous variables. ANOVA tests were applied to assess differences in continuous variables between groups. Frequencies were utilized for categorical variables, along with Chi-square tests. T-tests were performed to evaluate differences between Matrix and HFA parameters. It was used a Pearson correlation to observe the bivariate association of the parameters between the OCT and the Matrix.

Results

138 eyes of 72 patients, 26 healthy, 19 with a GPAA diagnosis and 27 as glaucoma suspects, were studied. The demographic and eye clinical characteristics of the patients are shown in table 1-3. There was no statistically meaningful statistically differences in the age nor in the sex of the patients.

	Healthy n = 26	Glaucoma Suspect n = 27	Glaucoma n = 19	p
F/M n	19/7	19/8	10/9	0.163
Age Average (sd)	60 (8.2)	60 (14.8)	64 (8.1)	0.09

Table 1: *Demographic characteristics.*

Variable Mean (sd)	Healthy n = 50	Glaucoma n = 36	Glaucoma Suspect n = 52	p Anova
Vertical C/D ratio	0.65 (0.13)	0.88 (0.08)	0.72 (0.15)	0.000
DM HFA (dB)	-0.21 (1.2)	-5.48 (7.02)	-1.11 (1.15)	0.000
DSM HFA (dB)	1.46 (0.33)	5.21 (3.63)	1.85 (0.35)	0.000
DM Matrix (dB)	0.85 (2.22)	-6.53 (5.71)	-2.36 (2.22)	0.000
DEP Matrix (dB)	2.6 (0.45)	5.1 (2.11)	3.6 (1.03)	0.000

Table 2: *Clinical characteristics.*

Variable	Healthy n = 50	Glaucoma n = 36	Glaucoma Suspect n = 52	p Anova
Retinal nerve fiber layer				
Avg	109.87	87.63	97.64	0.000
Sup	108.98	87.37	97.09	0.000
Inf	110.75	87.88	98.14	0.000
Ganglion Cell Complex				
Avg	95.19	81.97	87.28	0.000
Sup	94.25	83.09	87.76	0.000
Inf	96.15	80.84	86.79	0.000
FLV	0.524	4.369	1.728	0.000
GLV	4.41	15.59	10.63	0.000

Table 3: *Thickness in microns of the retinal nerve fiber layer and ganglion cell complex.*

The dB average of the DM in the group of healthy patients was bigger when using Matrix and smaller in the group of glaucoma patients and glaucoma suspect patients.

The dB average of the DS in the group of healthy patients and glaucoma suspect patients was bigger when using Matrix than when using HFA. And there was no difference in the group of glaucoma patients (Table 4, 5 and graph 1).

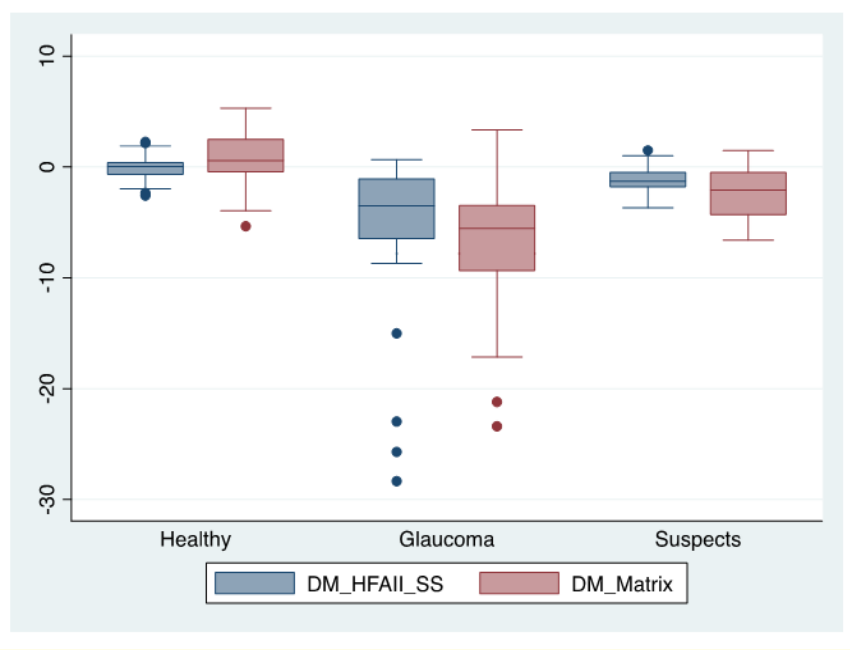
A meaningful positive correlation was found between the Matrix DM and the OCT general parameters ($p < 0.05$) (Table 6).

	DM Matrix	DM_HFA	p t pareada
Healthy	0.85 (2.22)	-0.21 (1.2)	0.001
Glaucoma Suspect	-2.36 (2.22)	-1.11 (1.15)	0.050
Glaucoma	-6.53 (5.71)	-5.48 (7.02)	0.001

Table 4: *Comparison between DM Matrix and HFA. There was a meaningful statistically difference.*

	PSD Matrix	PSD_HFA	P t paired
Healthy	2.6 (0.45)	1.46 (0.33)	0.000
Glaucoma Suspect	3.6 (1.03)	1.85 (0.35)	0.000
Glaucoma	5.1 (2.11)	5.21 (3.63)	0.834

Table 5: *Comparison between PSD Matrix and HFA. The average of dB in the group of healthy and glaucoma suspect patients was meaningfully bigger.*

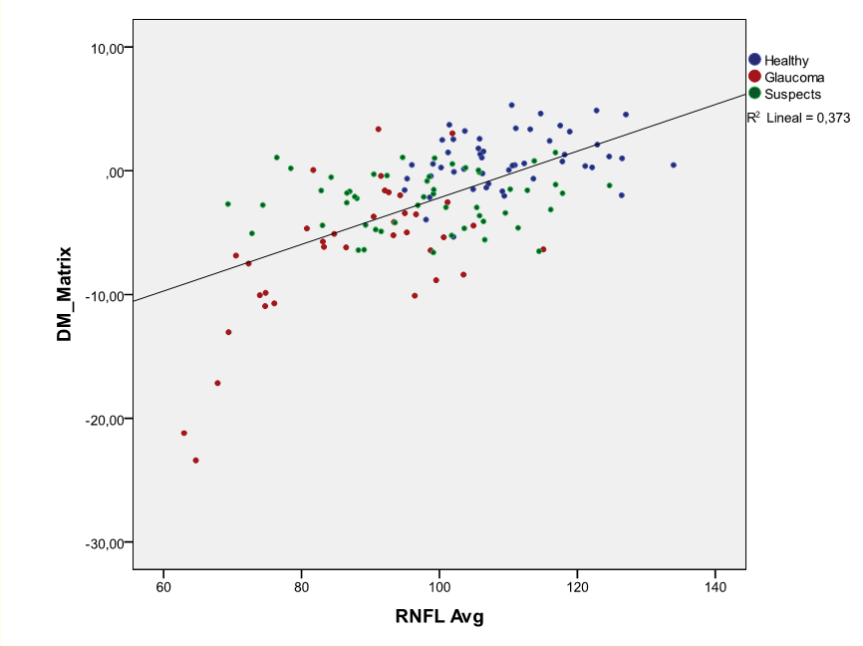


Graph 1: *Comparative DM dB between HFA and Matrix by groups.*

Pearson	RNFL Avg	GCC Avg	FLV	GLV
DM Matrix	r = 0.611 (0.000)	r = 0.485 (0.000)	r = -0.533 (0.000)	r = -0.525 (0.000)
PSD Matrix	r = -0.408 (0.000)	r = -0.280 (0.001)	r = 0.384 (0.000)	r = 0.299 (0.000)

Table 6: *Pearson Correlation between Matrix and OCT in all participants.*

The strongest correlation was found between the DM and the average thickness of the nerve fiber layer with an $R^2 = 0.37$ ($p < 0.05$) (Graph 2).



Graph 2: *Coeficient correlation by groups.*

When analyzing by groups, a meaningful positive correlation was found in the glaucoma patients. Nevertheless, no correlation between these parameters was not found any correlation of these parameters in the glaucoma suspect patients (Table 7).

Discussion

Glaucoma is characterized by a specific kind of damage in the optic nerve head and in the retinal fiber layer as well as by visual field loss. Early detection of glaucoma is really important, primarily because the quality of life may be adversely affected with even a light loss of the visual field. Both, structural and functional tests, are needed for early diagnosis [14-17]. Most diagnostic tests are less accurate when applied to recently diagnosed people than when applied to advanced diagnosed people.

Studies comparing the diagnostic ability of different perimetric tests have reported mixed results. Tafreshi., *et al*. compared SAP, matrix FDT and SITA SWAP, but he found no significant difference in their diagnostic performance [18]. In contrast, Medeiros., *et al*. found that

Variable r Pearson	Healthy n = 50	Glaucoma n = 36	Glaucoma Suspect n = 52
RNFL and DM Matrix			
Avg	0.325 *	0.631 *	0.073
Sup	0.240	0.523 *	0.133
Inf	0.335 *	0.604 *	0.100
GCC and DM Matrix			
Avg	0.158	0.437 *	0.011
Sup	0.179	0.214	-0.018
Inf	0.125	0.473 *	0.042
FLV and DM Matrix	0.121	-0.501 *	0.104
GLV and Matrix	-0.107	-0.486 *	0.003

Table 7: *Pearson correlation between matrix and OCT by groups.*

FDT may have better accuracy in early disease detection [19]. Tatham., *et al*. also found that matrix FDT performed better than SAP in early glaucoma detection [20]. In this study, the dB average of Matrix DM was smaller in glaucoma patients and glaucoma suspects than the dB average of HFA DM. The dB average of Matrix DSP in the group of healthy individuals and glaucoma suspects was bigger when using Matrix than when using HFA. So, in the glaucoma suspects group, the dB average of Matrix DM was smaller than the dB average of HFA DM and the dB average of Matrix DSP was bigger than the dB average of HFA; which means, that the Matrix DSP is more sensitive to localized defects in this group of patients. In fact, Naghizadeh., *et al*. mentioned that for a visual field progression, when there is an increase in the PSD, that is going to reflect a progression in early and moderate glaucoma before a change of the DM could be seen. Prokosh., *et al*. described a significant difference of Matrix MD between early glaucoma patients with RNFL defects and normal individuals without RNFL defects, while SAP did not. The visual field index PSD, however, did not show any significant difference [22].

A meaningful positive correlation was found between the Matrix DM and the OCT general parameters. The strongest one was observed between the Matrix DM and the average thickness of the nerve fiber layer. When analyzing by groups, a meaningful positive correlation was found in glaucoma patients; nevertheless, no correlation was found in the glaucoma suspects group. These discoveries agree with Bengtsson et. al., who mentioned that the discriminatory ability of the OCT depends on the seriousness of glaucoma. There again, this OCT ability has a better performance when discriminating between healthy and advanced diagnosed people than when discriminating in the early stages of glaucoma [23]. Lisboa., *et al*. demonstrated that RNFL parameters performed significantly better than ONH and macular parameters for detecting preperimetric glaucomatous damage [24]. On the other hand, other authors showed that detection of early structural progression of glaucoma may be faster with pattern-based GCC parameters of the RTVue OCT than any ONH, RNFL or average GCC parameter of the same instrument [21]. Sha., *et al*. showed that the combined evaluation of FDT and structural data can increase the number of correctly perimetric glaucoma patients [25]. Horn., *et al*. showed that FDT-perimetry and SDOCT are able to expose a considerable quantity of glaucoma patients with visual field losses and quite a number of patients with early forms of the disease [26]. In this study, in the correlation test, nearly half of the glaucoma suspects got really close to the glaucoma group, which means that they should be kept under observation.

Conclusion

In conclusion, we found a strong correlation between Matrix DM and the average thickness RNFL in the glaucoma group. In the glaucoma suspects group, the dB average of Matrix PSD was bigger than the dB average of HFA. The mixed use of structural and functional testing can be helpful in glaucoma detection.

Bibliography

1. Quigley HA. "Number of people with glaucoma worldwide". *British Journal of Ophthalmology* 80 (1996): 389-393.

2. Quigley HA and Broman AT. "Number of people with glaucoma worldwide in 2010 and 2020". *British Journal of Ophthalmology* 90 (2006): 262-267.

3. Caprioli J. "The importance of rates in glaucoma". *American Journal of Ophthalmology* 145 (2008): 191-192.

4. King AJ., *et al.* "The rates of blindness and of partial sight registration in glaucoma patients". *Eye* 14 (2000): 613-619.

5. Quigley HA., *et al.* "Optic nerve damage in human glaucoma. III. Quantitative correlation of nerve fiber loss and visual field defect in glaucoma,ischemic neuropathy, papilledema and toxic neuropathy". *Archives of Ophthalmology* 100 (1982): 135-146.

6. Kerrigan-Baumrind LA., *et al.* "Number of ganglion cells in glaucoma eyes compared with threshold visual field tests in the same persons". *Investigative Ophthalmology and Visual Science* 41 (2000): 741-748.

7. Anderson AJ., *et al.* "Characteristic of the normative database for the Humphrey matrix perimeter". *Investigative Ophthalmology and Visual Science* 46 (2005): 1540-1548.

8. Artes PH., *et al.* "Threshold and variability properties of matrix frequency-doubling technology and standard automated perimetry in glaucoma". *Investigative Ophthalmology and Visual Science* 46 (2005): 2451-2457.

9. Skaf M., *et al.* "Retinal nerve fiber layer thickness profile in normal eyes using third-generation optical coherence tomography". *Eye* 20 (2006): 431-439.

10. Savini G., *et al.* "Spectral-domain optical coherence tomography for the diagnosis and follow-up of glaucoma". *Current Opinion in Ophthalmology* 22 (2011): 115-123.

11. Tan O., *et al.* "Detection of macular ganglion cell loss in glaucoma by Fourier-domain optical coherence tomography". *Ophthalmology* 116 (2009): 2305-2314.

12. Garas A., *et al.* "Comparison of repeat-ability of Retinal Nerve Fiber Layer Thickness measurement made using the RTVue Fourier-domanin Optical Coherence Tomograph and the GDx Scanning Laser Polarimeter with variable or enhanced corneal compensation". *Journal of Glaucoma* 19 (2010): 412-417.

13. Seong M., *et al.* "Diagnostic comparison between macular and peripapillary retinia Nerve Fiber Layer measurements by Spectral Domain Optical Coherence Tomography in Normal Tension Glaucoma". *Investigative Ophthalmology and Visual Science* 51 (2010): 1446-1452.

14. Harwerth RS., *et al.* "Neural losses correlated with visual losses in clinical perimetry". *Investigative Ophthalmology and Visual Science* 45 (2004): 3152-3160.

15. Garway-Heath DF., *et al.* "Scaling the hill of vision: the physiological relationship between light sensitivity and ganglion cell numbers". *Investigative Ophthalmology and Visual Science* 41 (2000): 1774-1782.

16. Medeiros FA., *et al.* "Estimating the rate of retinal ganglion cell loss in glaucoma". *American Journal of Ophthalmology* 154 (2012): 814-824.

17. Medeiros FA., *et al.* "The structure and function relationship in glaucoma: implications for detection of progression and measurement of rates of change". *Investigative Ophthalmology and Visual Science* 53 (2012): 6939-6946.

18. Tafreshi A., *et al.* "Visual function-specific perimetry to identify glaucomatous visual loss using three different definitions of visual field abnormality". *Investigative Ophthalmology and Visual Science* 50 (2009): 1234-1240.

19. Medeiros FA., *et al.* "A statistical approach to the evaluation of covariate effects on the receiver operating characteristic curves of diagnostic tests in glaucoma". *Investigative Ophthalmology and Visual Science* 47 (2006): 2520-2527.

20. Tatham AJ., *et al.* "Strategies for improving early detection of glaucoma: the combined structure-function index". *Clinical Ophthalmology* 8 (2014): 611-621.

21. Naghizadeh F., *et al.* "Detection of early glaucomatous progression with different parameters of the RTVue Optical Coherence Tomograph". *Journal of Glaucoma* 195 (2014): 198.

22. Prokosch V and Eter N. "Correlation between early retinal nerve fiber layer loss and visual field loss determined by three different perimetric strategies: white on white, frequency-doubling, or flicker-defined form perimetry". *Graefe's Archive for Clinical and Experimental Ophthalmology* 252 (2014): 1599-1606.

23. Bengtsson B., *et al.* "Performance of time domain and spectral domain Optical Coherence Tomography for glaucoma screening". *Acta Ophthalmologica* 90 (2010): 310-315.

24. Lisboa R., *et al.* "Comparison of different spectral domain OCT scanning protocols for diagnosing preperimetric glaucoma". *Investigative Ophthalmology and Visual Science* 54 (2013): 3417-3425.

25. Shah NN., *et al.* "Combining structural and functional testing for detection of glaucoma". *Ophthalmology* 113 (2006): 1593-1602.

26. Horn FK., *et al.* "Frequency doubling technique perimetry and spectral domain optical coherence tomography in patients with early glaucoma". *Eye* 25.1 (2011): 17-29.

Volume 11 Issue 8 August 2020