

# The “Topography” of Glaucomatous Defect Using OCT and Visual Field Examination

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## ABSTRACT

**Aim:** To describe the modifications in the superior and inferior retinal nerve fiber layer (RNFL) thickness regarding the distribution of the VF defects for the horizontal meridians in glaucomatous patients and the differences in the RNFL thickness topography between glaucomatous and healthy subjects.

**Methods:** One hundred twenty eyes of 91 patients affected by glaucoma and 94 eyes of 51 normal patients were retrospectively reviewed. Computerized 30°VF (Octopus G1 Dynamic strategy) and optical coherence tomography (OCT) ONH and 3D disk analysis were performed in all cases. The RNFL thickness measures analyzed in both groups were superior-nasal (SN), superior-temporal (ST), inferior-nasal (IN), and inferior temporal (IT) sectors. The VFs were classified according to the distribution of the VF defect as for the horizontal meridian in the pattern deviation plot as superior, inferior, predominantly superior, or predominantly inferior.

**Result:** In the glaucomatous group, 78 eyes (65%) showed a predominantly superior VF defect, while 38 eyes (32%) showed a predominantly inferior VF defect. Fifty-six eyes (46.7%) presented an exclusively superior, and 27/120 eyes (22.5%) presented an exclusively inferior VF defect. In the control group, the thickest RNFL sector was IT. The ST sector showed the thickest RNFL in presence of an exclusive superior VF defect. In case of an exclusive inferior VF defect, the thickest RNFL was the IT sector. VF showing superior defect presented a more altered MD than the VF with an inferior defect.

**Conclusion:** Glaucomatous damage affects both the superior and inferior neural rim almost simultaneously. However, the neural rim loss seems to be asymmetric, involving the inferior or superior rim depending on the predominant involvement of the superior or inferior hemifield at the VF test. Particularly, the IT sector appears to be the most compromised in glaucomatous eyes. Therefore, the asymmetry between superior and inferior RNFL could support the diagnosis of glaucoma.

**Keywords:** Glaucoma, OCT, RNFL, Visual field.

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## INTRODUCTION

Glaucomatous disease is a degenerative optic neuropathy leading to apoptosis of retinal ganglion cells and cupping of the optic nerve head.<sup>1</sup> It leads to a progressive alteration of the visual field (VF).<sup>2</sup> Therefore, the computerized VF test has become the gold standard for detecting the onset and the evolution of glaucomatous defects.<sup>3,4</sup> The retinal fiber layer (RNFL) and the ganglion cell complex (GCC) analysis obtained through optical coherence tomography (OCT) demonstrated a good correlation with retinal sensitivity detected on the VF test,<sup>5-7</sup> even at the pre-perimetric stage.<sup>8</sup>

Several risk factors have been involved in developing glaucoma, including older age, increased cup-disk ratio, high intraocular pressure (IOP), a higher pattern standard deviation, and thinner central corneal thickness.<sup>9</sup> Nevertheless, IOP reduction is still considered the most relevant therapeutic approach to prevent further glaucomatous damage.<sup>10-13</sup> The optic nerve head morphology is pivotal to diagnose the disease. When estimating the optic disk, the presence of vertical cupping is highly indicative of glaucomatous damage.<sup>9,14</sup>

The present study aimed to describe the modifications in the thickness of superior and inferior peripapillary nerve fibers regarding the distribution of the VF defects for the horizontal meridians in POAG patients and the possible clinical implications related to a predominantly superior or inferior VF defect among glaucomatous eyes. Moreover, to reveal possible differences in the peripapillary nerve fiber topography between glaucomatous and healthy subjects.

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**Conflicts of Interest:** None

## MATERIALS AND METHODS

Two hundred fourteen eyes of 142 Caucasian patients were retrospectively reviewed. Of these, 120 eyes of 91 patients (70.88 ± 10.54 years) suffering from glaucoma, while 94 eyes of 51 patients (56.96 ± 13.47 years) served as controls. The study complied with the tenets of the Declaration of Helsinki and with the Health Insurance Portability and Accountability Act of 1996.

POAG patients were defined as: untreated IOP > 21 mm Hg, glaucomatous features of optic nerve head, identifiable trabecular meshwork at gonioscopy, at least three adjacent points with a level of significance inferior to 5% on the pattern deviation plot with at least 1 point with a significance inferior to 1% at visual

field examination, or an abnormal glaucoma hemifield test, or a loss variance (LV) <2.5 dB, and one or more abnormal RNFL sectors at spectral-domain (SD) OCT exam. The control group consisted of subjects with an unremarkable ophthalmic examination and ophthalmoscopically normal optic nerve head appearance, IOP inferior to 21 mm Hg, absence of visual field defects on Octopus visual field test (Octopus G1 Dynamic strategy), and RNFL sectors within normal limits at SD-OCT. Exclusion criteria were: spherical defect greater than ± 5 diopters, ocular media opacities that preclude the execution of VF or OCT, any other ocular pathologies, retinal laser photocoagulation, or previous ocular surgery other than trabeculectomy or phacoemulsification of cataract.

**OCT Examination**

All subjects were analyzed on SD-OCT (iVue Optovue Inc., Fremont, CA) using ONH and 3D disk analysis. Scans with quality/signal strength inferior to 40/100 were not considered suitable for the study.

The software automatically generates a map showing the RNFL thickness measured 3.45-mm from the center of the optic disk. The RNFL thickness measures analyzed in both groups were superior-nasal (SN), superior-temporal (ST), inferior-nasal (IN), and inferior temporal (IT) sectors (Fig. 1).

**Visual Field Assessment**

Computerized 30°VF using Octopus G1 Dynamic strategy was performed in all cases. The VF exams with false-negative errors greater than 15%, false-positive errors greater than 15%, and fixation loss > 20% were excluded. The VFs were grouped

according to the distribution of the VF defect as for the horizontal meridian in the pattern deviation plot as superior or inferior. The VFs were predominantly superior or predominantly inferior when more than 50% of the defects were located in the respective hemifield.

**Statistical Analysis**

Parameters are expressed as mean ± standard deviation. *t*-test was used to establish the statistical significance of differences between variables. *p* values less than 0.05 were considered statistically significant. SPSS software (ver.20; SPSS, Inc., Chicago, IL) was used for statistics.

**RESULTS**

The average mean defect was -9.61 ± 5.68 dB (ranging from -0.7 to -26.3 dB) in the glaucomatous group and +0.14 ± 1.5 dB in the control group (ranging from +3.4 to -4.3 dB, *p*.0001). In the glaucomatous group, 78 eyes (65%) showed a predominantly superior VF defect, while 38 eyes (32%) showed a predominantly inferior VF defect, and four eyes (3%) did not exhibit any predominant hemifield distribution. Moreover, 56/120 eyes (46.7%) presented an exclusively superior, and 27/120 eyes (22.5%) presented an exclusively inferior VF defect.

In the control group, the thickest RNFL sector was IT, followed by ST, IN, and SN sectors (Table 1). However, in the glaucomatous group, the ST represented the thickest RNFL sector with no statistical differences among the other sectors (*p*>0.05) (Table 1). Of note, the ST remained the thickest sector even in eyes with an exclusive superior defect at VF examination; no significant differences

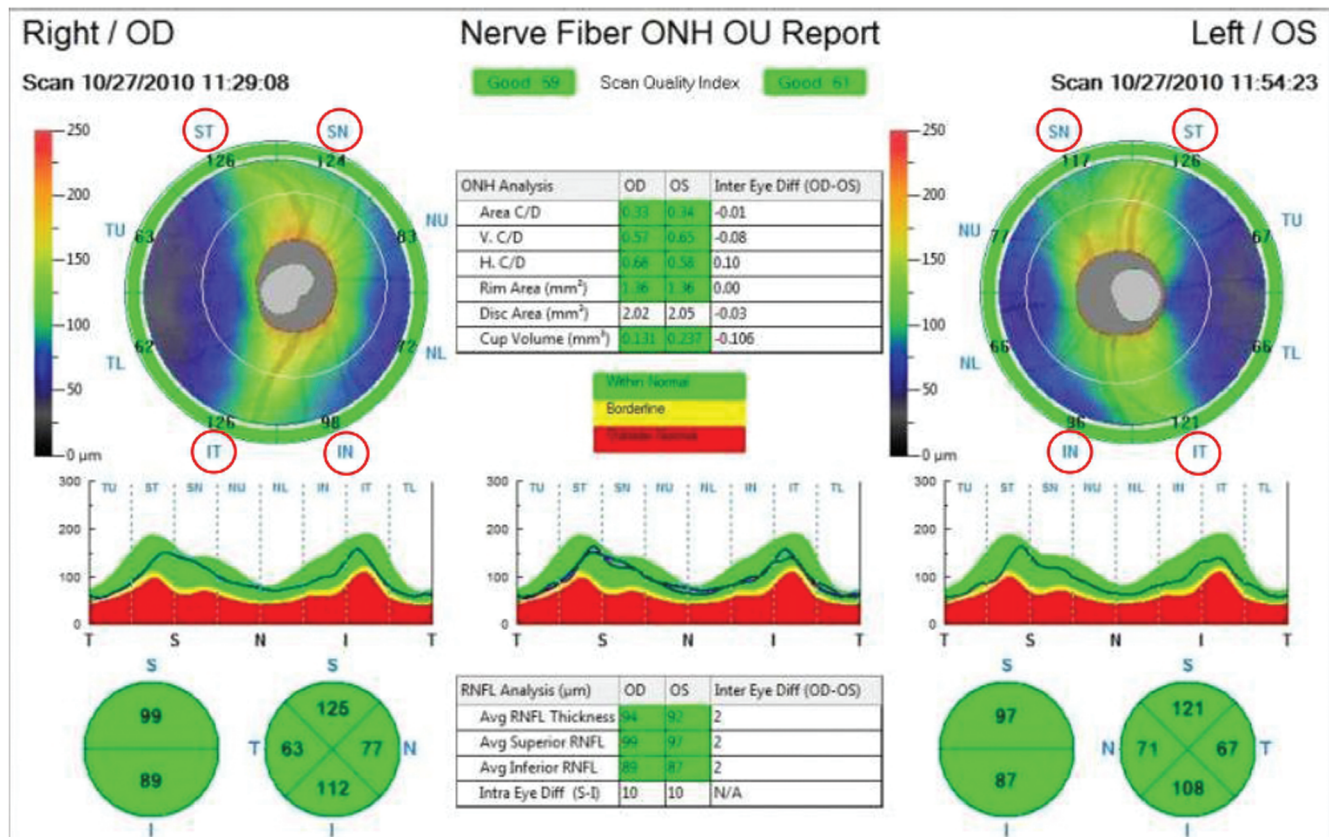


Fig. 1: OCT ONH analysis showing the analyzed sectors

