ORIGINAL ARTICLE

EVALUATION OF CUP DISC RATIO AND RNFL THICKNESS BASED ON GOLDMANN VISUAL FIELD TEST

Tatang Talka Gani[1,2,3], Retno Ekantini[1,2,3], Hartono[1,2,3], Krisna Dwi Purnomo Jati[1]
[1] Department of Ophthalmology, Universitas Gadjah Mada, Yogyakarta
[2] RSUP Dr. Sardjito Yogyakarta
[3] Yap Eye Hospital, Yogyakarta
Email: tg.tatang@yahoo.com

ABSTRACT

Introduction and Objective : *To assess the relationship between the cup-disc ratio of the optic nerve head and peripapilarry RNFL thickness to the visual field loss in glaucoma patients.*

Methods : *Visual field from Goldmann kinetic perimerty and Ocular Computed Tomography (OCT) records from Yap Eye Hospital, Yogyakarta are used to examine the figure of visual field loss in glaucoma patient.*

Result: *Broad spectrum of glaucoma-related visual field defects were observed from 73 eyes. The most common visual field defects are arcuate defect (23.3%) and followed by general depression. Arcuate defects can already observable in some patients with cup-disk ratio of 0.5 (30%).Arcuate defect occurs in the average RNFL thickness of 69.90 µm (46.93-118.77). It appears that the pinhole vision appeared on the average RNFL thickness of 44.23 µm (25.33-63.13), and temporal RNFL thickness remnant occured at 48.64 µm (46.22-51.06). RNFL thickness with normal visual field was on the thickness of 107.78 µm (100.27-115.29).*

Conclusion: *Visual field defect that may be observed in glaucoma with Goldmann kinetic perimetry are arcuate defect, and general visual field depression. RNFL thickness may be correlated longitudinally with the worsening of visual field defect.*

Keywords: *Glaucoma, Goldmann kinetic perimetry, visual field loss, OCT*

INTRODUCTION

Body laucoma represents a group of diseases defined by a characteristic optic neuropathy that is consistent with excavation and undermining of the neural and connective tissue elements of the optic disc and by the eventual development of distinctive patterns of visual dysfunction.[1] Although all forms of optic neuropathies exhibit loss of retinal ganglion cells and their axons, glaucoma is unique in having both retinal ganglion cell degeneration and chronic progressive deformation and remodeling of the optic nerve head (ONH).[2]

RNFL and ONH measurements had the best discriminating performance among the several Stratus OCT parameters. A combination of ONH and RNFL parameters improved the diagnostic accuracy for glaucoma detection using this instrument.[3] Optical coherence

tomography (OCT) produces high-resolution cross-sectional images of ocular tissues based on optical backscattering, akin to ultrasound technology.[4]

Measurable structural alterations of the optic nerve head may precede visual field abnormalities in early open-angle glaucoma.[5] Imaging technologies that analyze the structure of the optic nerve head, retinal nerve fiber layer, and macula provide quantitative information that complements, but does not replace, a thoughtful clinical examination of the optic nerve. Optic nerve imaging results from any of these devices should be analyzed and interpreted within the clinical context of an individual patient.[3]

Due to limitations of equipment, some ophthalmologists in Indonesia based glaucoma diagnosis only on the clinical condition of cupping of the optic nerve disc and the condition of the patient's IOP. This is due to the limitations of screening tools such as OCT or Visual Field Test (Perimetry) analyzer. This journal is trying to assess the correlation of disc cupping in glaucoma patients with their visual field defects. Furthermore, this journal will assess the correlation of RNFL thickness and visual field defects in glaucoma patients.

METHODS

Subjects

A total of 73 glaucoma eyes were studied. All subjects underwent measurement of visual acuity, refraction, intraocular pressure, and fundus examination by the ophthalmologist in Yap Eye Hospital. Glaucoma patients were diagnosed based on the presence of visual field defects with corresponding optic disc and RNFL changes in at least 1 eye independent of the level of intraocular pressure and the anterior chamber angle status. Eyes were excluded if the patients have other eye disorders other than glaucoma.

i. Inclusion Criteria:
- All type of glaucoma diagnosed by glaucoma specialist
- Pupil diameter > 3.0 mm;
- Best Corrected Visual Acuity > 6/60
- Clear optical media

ii. Exclusion Criteria
- Unreliable visual field pattern (determined by examinee)
- Prescence of ocular and systemic diseases likely to affect visual field.

Visual Field Examination

Visual field was examined with Goldmann perimetry, and was done by one expert. This test took 15 to 30 minutes to complete on each eye. It included at least four isopters encircling *360°,* and some static presentations.

Abnormal results on the Goldmann perimeter included the presence of nasal steps (defined as a discontinuity or depression in 1 or more nasal isopters near the horizontal raphe), arcuate defect (defined as an complete arches from the blind spot and ends at the nasal raphe), general depression, central depression, and pinhole vision.

Optical Coherence Tomography

We use Zeiss Stratus OCT, Model 3000 to image the RNFL. The Fast RNFL protocol was used to measure the RNFL thickness in region centered at the optic disc (avg RNFL) and defining the cup disc ratio (avg. CD-ratio). Image with signal strength of 6 or more were included in the analysis.

Statistic

All numeric data were collected in microsoft excel. Mean and percentage were generated directly with microsoft excel.

A total 73 eyes were observed between January 2014 and December 2015. The most common diagnosis was primary open angle glaucoma (67,12%) and followed by normal tension glaucoma (19,18%).

RESULTS

Primary open angle glaucoma and normal tension glaucoma were the most cases found in this study. The other were primary close angle glaucoma and secondary glaucoma.

Table 1. Clinical Glaucoma Diagnosis

Diagnosis by clincians	No. of patients	%
Chronic Angle Closure Glaucoma	3	4,11%
Secondary Glaucoma	4	5,48%
Normal Tension Glaucoma	14	19,18%
Primary Angle Closure Suspects	1	1,37%
Primary Angle Closure Glaucoma	2	2,74%
Primary Open Angle Glaucoma	49	67,12%

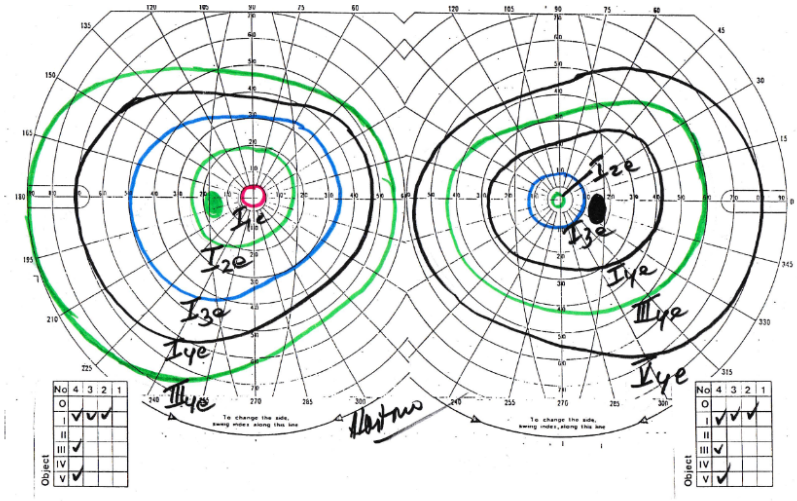

Figure 1. This patient had a generalized depression of visual field in both eyes. The right eye had a more severe depression of visual function than the left eye.

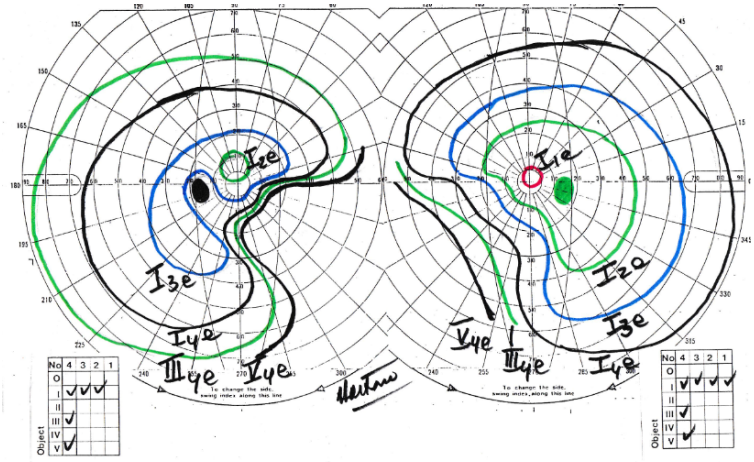

Figure 2. This patient had an inferior arcuate visual field defect in the left eye, and a nasal step in the right eye

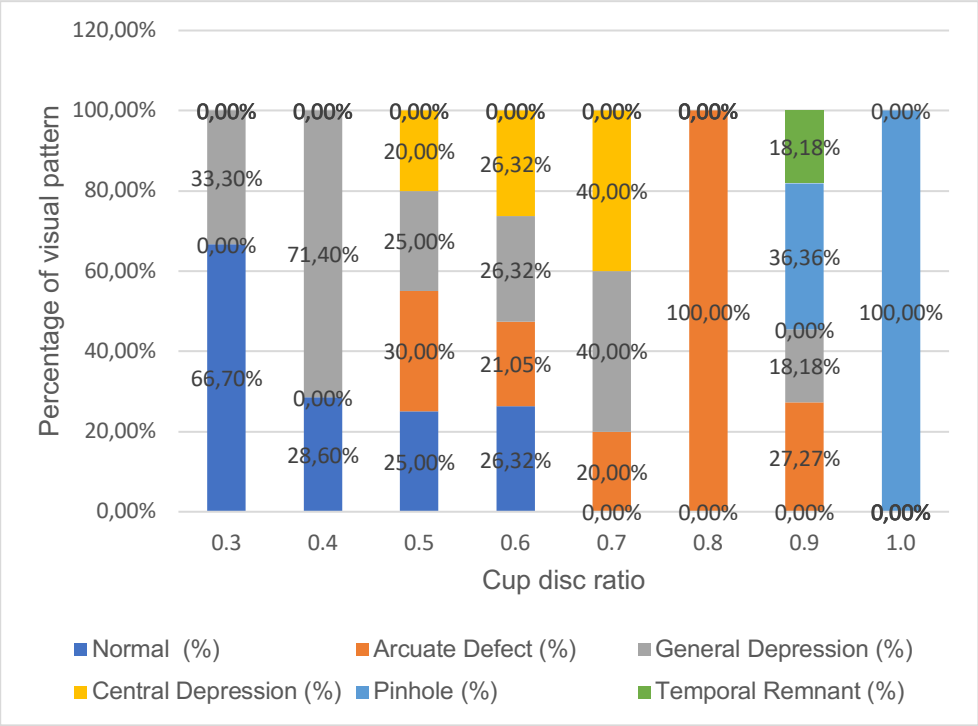

Figure 3. Condition of Cup-Disk Ratio and Visual Field Defect

In Figure 3, we can see typical visual field defects and the clinical picture cup-disc ratio. The most common visual field defects are arcuate defect (23.3%) and followed by general depression. Arcuate defects can already observable in some patients with cup-disk ratio of 0.5 (30%). All patients with cup-disc ratio of 1.0 had pinhole vision. (27.4%).

Table 2. Mean RNFL thickness and Visual Field Defect.

Visual Field Defect	Mean RNFL thickness
Normal	107.78 µm (100.27-115.29)
Arcuate defect	69.90 µm (46.93-118.77)
General depression	92.14 µm (65.51-118.77)
Central depression	102.21 µm (80.71-123.71)
Pinhole vision	44.23 µm (25.33-63.13)
Temporal remnant	48.64 µm (46.22-51.06)

Table 2 illustrates the condition mean RFNL thickness and field defects. In general, the thinner RNFL, the worse the visual field defects that occured. Arcuate defect occurs in the average RNFL thickness of 69.90 µm (46.93-118.77). It appears that the pinhole vision appeared on the average RNFL thickness of 44.23 µm (25.33-63.13), and temporal RNFL thickness remnant occured at 48.64 µm (46.22-51.06). RNFL thickness with normal visual field was on the thickness of 107.78 µm (100.27-115.29).

DISCUSSION

Glaucoma is a widespread, blindness-causing disease that is characterized in part by specific and sometimes subtle changes in optic disc and retinal nerve fiber layer topography. Detecting structural changes that precede visual function loss may be a key to vision preservation in glaucoma patients.[6] Several recently developed computer-based optical imaging techniques allow objective evaluation of the optic disc and retinal nerve fiber layer.[5] Measuring early structural RNFL thinning by OCT also provides an objective measurement in the evaluation of glaucoma patients. Although visual field testing is subjective and prone to inter-test variability, it remains the most common tool to detect functional vision loss in glaucoma patients.[7]

As has been observed previously, the typical defects in glaucoma generally appear as generalized depression, paracentral scotoma, arcuate or Bjerrum scotoma, nasal step, and altitudinal defect.[1] The site of damage to nerve fibers is the scleral lamina cribrosa, where there is local blockage of axonal transport. Early cup size increase prior to definite field loss results from loss of nerve fibers, not from damage to astrocytic glial cells of the nerve head.[8] There seems to be great variability in the appearance and progression of the initial glaucomatous optic disk and nerve fiber layer abnormalities in patients with increased intraocular pressure.[6]

From this study we can assume that the patient which already had a cup-disk ratio of 0.5 might have arcuate defect or general depression. In this study, the patient with cup-disc ratio above 0.9 had a very bad visual field, in the form of a pinhole vision or temporal remnant. No patients in this study had normal visual field on the condition of cup-disc ratio above 0.9. In this condition, the clinician should be very careful against the progression of the disease. Every risk factor for progression has to be controlled rigorously.

The retinal nerve fiber layer thickness is different in ocular hypertensive, normal, and glaucomatous eyes in optical coherence tomography.[9] The mean RNFL thickness for the entire population was 100.1 μm (standard deviation, 11.6). Thinner RNFL measurements were associated with older age, greater axial length, or smaller optic disc area.[10] In this study we do not include age as a variable. In this study we can see that the RNFL thickening was directly proportional to the worsening condition of the visual field. Thus, it can be estimated that the condition of the visual field damage has occurred in the conditions RNFL thickness of 69.90μm (46.93-118.77). Pinhole vision appeared on the average RNFL thickness of 44.23 μm (25.33-63.13), and temporal RNFL thickness remnant occured at 48.64 μm (46.22-51.06). RNFL thickness with normal visual field was on the thickness of 107.78 μm (100.27-115.29), in line with previous research.[9]

Serial nerve fiber layer examination was more sensitive than color disc evaluation in the detection of progressive glaucoma damage at this early stage of glaucoma. The evaluation of cup-to-disc ratio or of the nerve fiber layer appearance in the initial photograph taken 5 years before field loss were equally predictive of future field damage. The position of nerve fiber layer defects was highly correlated with the location of subsequent visual field loss.[11,12,13]

Goldmann's perimeter has been used by ophthalmologists for a long time, howeve it has some limitations. This tool requires special skills to obtain accurate results. Careless operator, or rushed process can lead to defects that should not be present in the patient. The operator's carelessness can also cause small and shallow visual field defects to be unseen. Another drawback is the different reaction time between operator and patient. This can cause the area recorded on examination to be smaller than it should be, or the scotomata recorded to be larger because the examiner is late in determining the margins of the patient's visual field abnormality.[14,15]

This study adds to the knowledge of the pattern of the visual field defect that we expected to appear on the Goldmann kinetic perimetry according to the thickness of the RNFL reading on the OCT. Clinician should now the range of visual field defects that occur on the condition of related cup-disc ratio and RNFL thickness, in places where there are no adequate facilities to undertake an examination of the visual field. Clinician is also expected to do better education with the approximation of visual field defects that patients have.

REFERENCES

1. Basic and clinical science course Section 10 Glaucoma. San Francisco: American Academy of Ophthalmology. 2019. 18 p.
2. Xu G, Weinreb RN, Leung CK. Optic nerve head deformation in glaucoma: the temporal relationship between optic nerve head surface depression and retinal nerve fiber layer thinning. Ophthalmology. 2014 Dec 1;121(12):2362-2370.
3. Medeiros FA, Zangwill LM, Bowd C, Vessani RM, Susanna Jr R, Weinreb RN. Evaluation of retinal nerve fiber layer, optic nerve head, and macular thickness measurements for glaucoma detection using optical coherence tomography. Am J Ophthalmol. 2005;139(1):44-55.
4. Zangwiil LM, Bowd C, Weinreb RN. Evaluating the optic disc and retinal nerve fiber layer in glaucoma II: optical image analysis. Taylor & Francis. 2000. (Vol. 15, No. 4, pp. 206-220).
5. Caprioli J, Miller JM, Sears M. Quantitative evaluation of the optic nerve head in patients with unilateral visual field loss from primary open-angle glaucoma. Ophthalmology. 1987;94(11):1484-1487.
6. Sommer A, Katz J, Quigley HA, et al. Clinically detectable nerve fiber atrophy precedes the onset of glaucomatous field loss. Arch Ophthalmol 1991;109(1):77–83.
7. Turalba AV, Grosskreutz C. A review of current technology used in evaluating visual function in glaucoma. Semin Ophthalmol 2010; 25(5–6):309–316.
8. Quigley HA, Addicks EM, Green WR, Maumenee AE. Optic nerve damage in human glaucoma: II. The site of injury and susceptibility to damage. Arch Ophthalmol. 1981; 1;99(4):635-649.
9. Bowd C, Weinreb RN, Williams JM, Zangwill LM. The retinal nerve fiber layer thickness in ocular

hypertensive, normal, and glaucomatous eyes with optical coherence tomography. Arch Ophthalmol. 2000 ;118(1):22-26.

10. Budenz DL, Anderson DR, Varma R, Schuman J, Cantor L, Savell J, Greenfield DS, Patella VM, Quigley HA, Tielsch J. Determinants of normal retinal nerve fiber layer thickness measured by Stratus OCT. Ophthalmology. 2007: 30;114(6):1046-1052.
11. Quigley HA, Katz J, Derick RJ, Gilbert D, Sommer A. An evaluation of optic disc and nerve fiber layer examinations in monitoring progression of early glaucoma damage. Ophthalmology. 1992;99(1):19-28.
12. Nils A. Loewen MD, P. A. Clinical Glaucoma Care- The Essentials. New York: Springer. 2014. 118 p.
13. Tuulonen A, Airaksinen PJ. Initial glaucomatous optic disk and retinal nerve fiber layer abnormalities and their progression. Am j ophthalmol. 1991;111(4):485-490.
14. Ramirez M, Chaya C, Gordon L & Giaconi J (2008): A comparison of semiautomated versus manual Goldmann kinetic perimetry in patients with visually significant glaucoma. J Glaucoma 17: 111–117.
15. Nowomiejska K, Brzozowska A, Zarnowski T, Rejdak R, Weleber RG & Schiefer U (2012): Variability in isopter position and fatigue during semi-automated kinetic perimetry. Ophtalmologica 227: 166–172.