

Original Article

Comparison of Peripapillary Retinal Nerve Fiber Layer (RNFL) Thickness between the Normal and Glaucoma Eyes with the Same Vertical Cup Disc Ratio (CDR) using Optical Coherence Tomography (OCT)

Ni Gusti Ayu Ari Raiasih*, Elvioza*, Virna Dwi Oktariana*, Joedo Prihartono**

* Department of Ophthalmology, Faculty of Medicine, Indonesia University
Cipto Mangunkusumo Hospital, Jakarta

** Department of Community Medicine, Faculty of Medicine, Indonesia University
Jakarta

ABSTRACT

Background: Glaucoma is a disease that belongs to a group of neurodegenerative diseases, such as impaired visual field and optic neuropathy with progressive damage to the optic nerve and retinal nerve fiber layer (RNFL) which is caused by the loss of ganglion cells and axon of the optic. Changes in the optic nerve and RNFL may occur prior to the abnormalities of the visual field nerves. Currently, the visual field examination should be performed to diagnose glaucoma but with patient-subjective result. Before it is detectable, visual field abnormalities are likely going to lose its ganglion cells by 40%. The purpose of this study was to assess and compare the peripapillary retinal nerve fiber layer (RNFL) between the normal and glaucoma eyes with vertical cup disc ratio (CDR) 0.4 to 0.7 in eye clinic Cipto Mangunkusumo Hospital (RSCM) Kirana.

Methods: A total of 40 eyes of normal group and 34 eyes of glaucoma following Humphrey field analyzer examination and Optical Coherence Tomography (OCT) were evaluated. Peripapillary RNFL thickness between normal and glaucoma eyes were analyzed and compared each other. Eyes of glaucoma group then were grouped into early-stage glaucoma, according to the criteria in the initial stages of the examination results of Humphrey field analyzer. Result of peripapillary RNFL thickness was analyzed to get a cut off value.

Results: Peripapillary RNFL thickness in the normal group with vertical CDR 0.4 to 0.7 was $111.3 \pm 9.8 \mu\text{m}$ to $118.0 \pm 3.0 \mu\text{m}$, and glaucoma groups with vertical CDR 0.4 to 0.7 was $105.6 \pm 12.6 \mu\text{m}$ to $113.7 \pm 6.1 \mu\text{m}$. Retinal nerve fiber layer thickness in normal group compared to glaucoma group in the superior quadrant, inferior, nasal, temporal and average on CDR 0.4 to 0.7 was not statistically significant ($p > 0.05$), except on vertical CDR 0.6 average peripapillary RNFL ($p < 0.05$). Cut off value of peripapillary RNFL in superior quadrant was $164 \mu\text{m}$, inferior $169.5 \mu\text{m}$, nasal $82.5 \mu\text{m}$, temporal $73.5 \mu\text{m}$ and average $111.8 \mu\text{m}$.

Conclusion: There was no difference in changes of peripapillary RNFL along with the progression of vertical CDR but clinically, peripapillary RNFL thickness in glaucoma group is thinner than that of normal group with the same vertical CDR except in temporal quadrant.

Keywords: Retinal nerve fiber layer (RNFL), cup disc ratio (CDR), optical coherence tomography (OCT)

Glaucoma is a disease that belongs to a group of neurodegenerative diseases, such as impaired visual field and optic neuropathy with progressive damage to the optic nerve and retinal fiber layer (RNFL) which is caused by the loss of ganglion cells and axon of the optic nerves.¹⁻³ Glaucoma becomes the second leading cause of blindness in the world with a prevalence estimated at 67 million.⁴⁻⁷ In the past 10 years (2001-2010), the suspected cases of glaucoma at RSCM was about 11.5% (371 cases).⁸

Changes in the optic nerve and RNFL may occur prior to the abnormalities of the visual field.^{3,9,10} Currently, the visual field examination should be performed to diagnose glaucoma but with patient-subjective result. Before it is detectable, visual field abnormalities are likely going to lose its ganglion cells by 40%.^{3,9}

Optical coherence tomography (OCT) is a tool that can quantitatively detect retinal structure and is a non-invasive, non-contact and objective.^{11,12} Many studies are looking for RNFL thickness at various conditions such as a study conducted by Lalezary et al¹³ that RNFL thinning was found in patients with suspected glaucoma which developed into glaucoma.

METHODS

This study used a comparative cross-sectional design, to compare peripapillary RNFL thickness in normal and glaucoma patients with vertical CDR 0.4 up to 0.7. The research was done in Glaucoma Polyclinic and General Ophthalmology Polyclinic at RSCM Kirana. The study started from December 2012 to February 2013. Samples were selected consecutively until the required sample size was achieved.

Inclusion criteria in the group of normal patients were age of 18 to 60 years, best corrected visual acuity (BCVA) $\geq 6/20$, refractive error between +3 D to -6 D, intra-ocular pressure (IOP) ≤ 21 mmHg, vertical CDR 0.4 to 0.7, and normal visual field test results, while the criteria for inclusion in the glaucoma group was similar with normal group with primary open angle glaucoma, juvenile glaucoma, normal tension glaucoma (NTG) or those who had not been medically or surgically treated. Total sample size for both group was 64 eyes, with a sample size of each CDR is the 8 eyes.

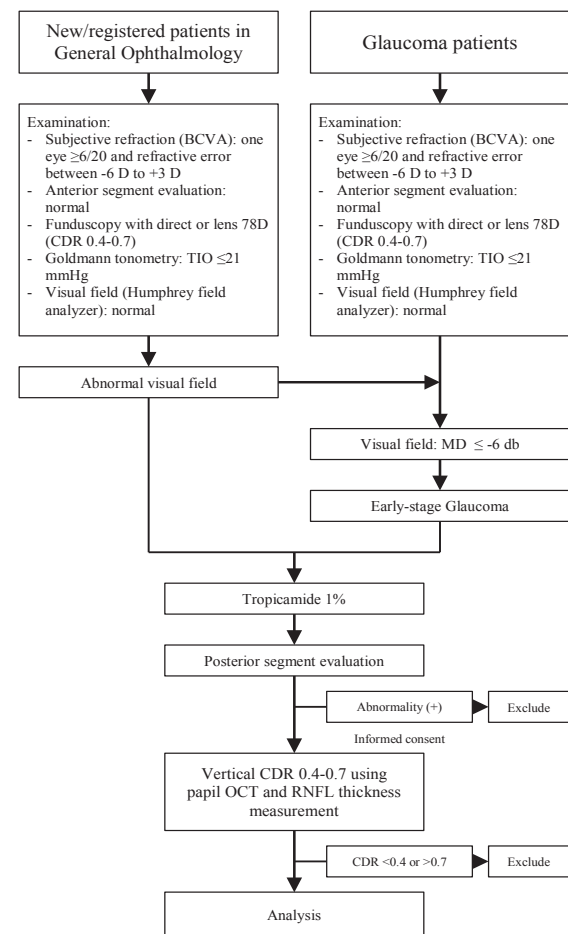


Fig 1. Scheme of the study

RESULTS

The distribution of the basic characteristics of the study subjects eyes mostly on the normal group and the majority of the respondents were women both in the normal and glaucoma groups. The age of majority in the normal group was less than 40 years of age in 14 eyes (35%) and in the glaucoma group was more than 50 years of age in 13 eyes (38.2%), with a mean age in the normal group was 44.7 ± 10.6 while in the glaucoma group was 44.7 ± 10.9 . Median refraction in the normal group was 0.00 with range of -5.63 to +3.75, while the glaucoma group was -0.25 with range of -0.00 to +2.00.

In this study, the mean RNFL thickness in the quadrant peripapil superior, inferior, nasal, temporal and average on CDR 0.4 to 0.7 in the normal group was not significantly compared to glaucoma group, except at CDR 0.6 average peripapillary RNFL thickness with p-values < 0.05 ($p = 0.008$).

Table 1. Features of mean thickness of peripapillary RNFL

Quadrant	RNFL Thickness				P
	Normal		Glaucoma		
	Mean	SD	Mean	SD	
Superior	174.8	18.5	165.3	20.4	0.039
Inferior	181.7	26.0	175.3	24.9	0.281
Nasal	92.4	16.2	87.2	20.0	0.220
Temporal	76.6	12.7	77.3	13.3	0.813
Average	115.1	8.3	110.1	9.4	0.018

RNFL: Retinal Nerve Fiber Layer; SD: Standard Deviation

In this study, peripapillary RNFL thickness in each group of vertical CDR 0.4 to 0.7 was clinically thinner in the glaucoma group rather than in the normal group, except the vertical CDR 0.5 in the superior quadrant, vertical CDR 0.4 in the inferior quadrant, vertical CDR 0.4 and 0.6 in the temporal quadrant.

Cut-off value of superior quadrant RNFL thickness was 164 µm with a sensitivity of 70%

and specificity of 53%, inferior was 169.5 µm with 63.4% sensitivity and 53.3% specificity, nasal was 82.5 µm with sensitivity of 75% and specificity of 50%, 73.5 µm temporally with sensitivity of 52.5% and specificity of 36.7%, and average was 111.8 µm with 68.3% sensitivity and 53.3% specificity.

DISCUSSION

Research conducted by PK Gupta et al¹⁴ that compared RNFL thickness of the optic nerve between nonglaucomatous and glaucomatous found that mean age in patients with nonglaucomatous optic nerve (43±19.8 years) was lower than in glaucomatous group (67.8±12.5 years). Research conducted by SMG Kaw et al¹⁵ found that mean age in the normal group was 62.5±7.7 years and 60.9±7.6 years in the glaucoma group.

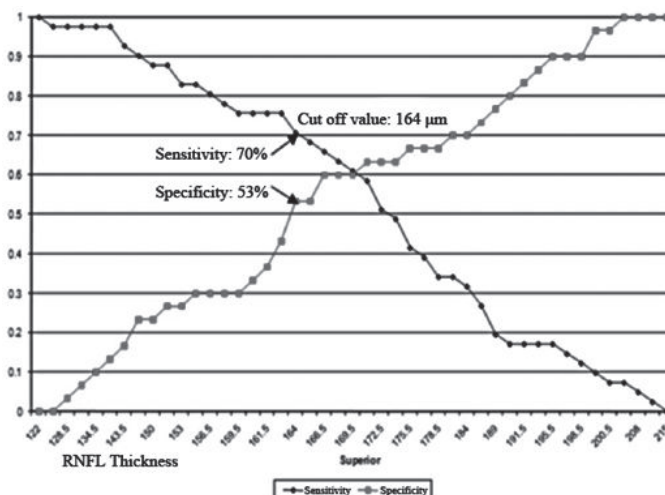


Fig 2. Cut-off value of superior RNFL

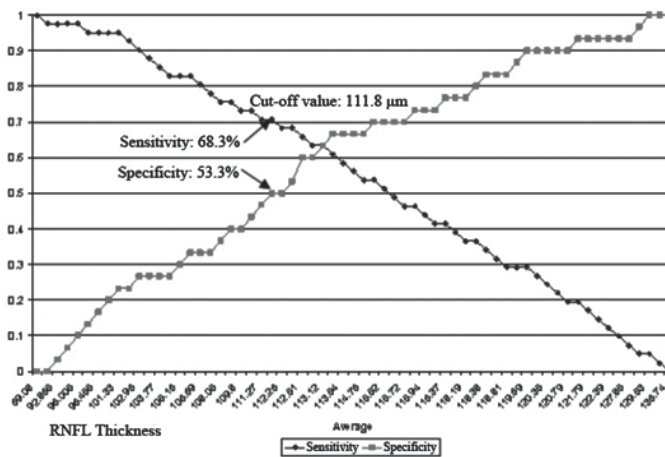


Fig 1. Cut-off value of average RNFL

Fig 3. Cut-off value of average RNFL

Refractive status in this study in the normal and glaucoma groups was similar, with the range of -5.63 to +3.75 D in the normal group and -6.00 to +2.00 D in the glaucoma group. It is known that the peripapillary RNFL thickness will affect patients with high myopia, that RNFL thinning by 0.9 μm in every 1 D usually happens.¹⁶ However, any change in the refractive error in the study based on inclusion criteria was limited to -6.00 D. This would not be a bias because it did not affect the RNFL thickness.

Results of mean RNFL thickness between normal subjects and glaucoma eye were not significant, except in average RNFL of CDR 0.6 average. This was likely due to the small number of samples.

The average RNFL thickness between normal and glaucoma groups in the superior quadrant and average was significantly different regardless CDR value. This is because the superior quadrant has the highest exposure to high IOP.¹⁷

In this study, the mean RNFL thickness in normal and early stage glaucoma group was significant in the superior quadrant, 164 μm , and the average value was 111.8 μm ($p < 0.05$). This value is regarded cut-off value, which can be used as a reference in providing information to help in diagnosing early-stage glaucoma. However, because it didn't have high sensitivity, there should be a further research to prove it.

CONCLUSION

There was no difference in changes of peripapillary RNFL along with the progression of vertical CDR. However, the peripapillary RNFL thickness in glaucoma group was clinically thinner than that of normal group with the same vertical CDR, except in temporal quadrant.

REFERENCES

- Greenfield DS. Optic nerve and retinal nerve fiber layer analyzers in glaucoma. *Curr Opin Ophthalmol* 2002;13:68-76.
- Vrabec JP, Levin LA. The neurobiology of cell death in glaucoma. *Eye* 2007;21:11-4.
- Yuan F, Ying-zi P, Mei L, Rong-hua Q, Yu C. Diagnostic capability of Fourier-Domain optical coherence tomography in early primary open angle glaucoma. *Chin Med J* 2010; 123(15):2045-50.
- American Academy of Ophthalmology Staff. Introduction to glaucoma: terminology, epidemiology and heredity. *Glaucoma Basic Clinical Science Course*. San Francisco: American Academy of Ophthalmology; 2009-2010.
- Racette L, Zangwill LM, Weinreb RN, Sample PA. Primary open angle glaucoma in Blacks: a review. *Surv of Ophthalmol* 2003;48:295-313.
- Gindoff SA, Lawson J, Lawson K, Morgan TH. *Doctor's Updated Guide*. 2004:1-33.
- Topouzis F, Anastasopoulos E. Glaucoma—the importance of early detection and early treatment. *Touch Briefings* 2007:12-3.
- Faiqoh M, Artini W. Karakteristik pasien baru di divisi glaukoma poliklinik mata RSCM tahun 2001-2010. Jakarta. Universitas Indonesia 2011:1-20.
- Budenz DL, Chang RT, Huang X, Knighton RW, Tielsch JM. Reproducibility of retinal nerve fiber thickness measurements using the stratus OCT in normal and glaucomatous eyes. *Invest Ophthalmol Vis Sci* 2005;46:2440-3.
- Ophir A. First visit diagnosis of preperimetric glaucoma. *The Open Ophthalmology Journal* 2010;4:22-7.
- Alamouti B, Funk J. Retinal thickness decreases with age: an OCT study. *Br J Ophthalmol* 2003;87:899-901.
- Bourne RRA, Medeiros FA, Bowd C, Jahanbakhsh K, Zangwill LM, Weinreb RN. Comparability of retinal nerve fiber layer thickness measurements of optical coherence tomography instruments. *Invest Ophthalmol Vis Sci* 2005;46: 1280-5.
- Lalezary M, Medeiros FA, Weinreb RN, Bowd C, Sample PA, Tavares IM, et al. Baseline optical coherence tomography predicts the development of glaucomatous change in glaucoma suspects. *Am J Ophthalmol* 2006;142: 576-82.
- Gupta PK, Asrani S, Freedman SF, El-Dairi M, Bhatti M. Differentiating glaucomatous from non-glaucomatous optic nerve cupping by optical coherence tomography. *The Open Neurology Journal* 2011:3-7.
- Kaw SMG, Martinez JM, Tumbocon JA, Atienza NJ. Correlation of average RNFL thickness using the Stratus OCT with the perimetric staging of glaucoma. *Philippine Journal of Ophthalmology* 2012;37:19-23.
- Budenz DL, Anderson DR, Varma R, Schuman J, Cantor L, et al. Determinants of normal retinal nerve fiber layer thickness measured by Stratus OCT. *Ophthalmology* 2007; 114:1046-52.
- American Academy of Ophthalmology Staff. *Glaucoma Clinical Evaluation*. San Francisco: American Academy of Ophthalmology; 2010-2011.p.33-83.