

Comparing Diagnostic Accuracy of Minimum Rim Width (MRW) and Retinal Nerve Fibre Layer (RNFL) in Detection of Glaucoma

MRW and RNFL
in Detection of
Glaucoma

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ABSTRACT

Objective: To evaluate and compare the diagnostic accuracy of minimum rim width and Retinal Nerve Fiber Layer in detection of glaucoma by taking cup-to-disc ratio as gold standard.

Study Design: Descriptive observational study

Place and Duration of Study: This study was conducted at the Ophthalmology department of Ghazi Hospital Dera Ghazi Khan from March 2022 to August 2022.

Methods: The study enrolled healthy individuals and those identified as glaucoma suspects based on criteria such as cup-to-disc ratio or elevated intraocular pressure exceeding 21 mmHg, who were attending the eye clinic. Main variables of study were co-morbidities (diabetes and hypertension), cup to disc ratio, diagnostic accuracy, sensitivity and specificity.

Results: A total of 300 patients were enrolled. There were 96.3% patients diagnosed with glaucoma by using cup to disk ratio, 85.3% were diagnosed with glaucoma by using RNFL and 87.7% patients diagnosed with glaucoma by using MRW. Sensitivity was 87.9%, 90.3%, specificity 81.8%, 81.8%, PPV 92.2%, 92.2%, NPV 20.5%, 24.3% and accuracy 87.7%, 90% of RNFL and MRW with cup to disk ratio using as a gold standard.

Conclusion: The diagnostic sensitivity for glaucoma is higher with retinal nerve fiber layer (RNFL) measurements compared to minimum rim width (MRW), but the specificity is equal for both. In myopic eyes, Bruch's membrane opening minimum rim width is comparable to RNFL thickness, making it a valuable diagnostic tool for identifying glaucoma in patients with myopic optic discs.

Key Words: Glaucoma, Minimum Rim Width, Retinal Nerve Fibre Layer, Diagnostic accuracy, Cup to disc ratio

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INTRODUCTION

Glaucoma is a medical illness of eye that affects the optic nerve. Glaucoma can lead to a gradual and irreversible loss of vision if not detected and treated early.¹ The incidence of glaucoma in Pakistan, as well as globally, varies, with estimates suggesting that it affects approximately 4.5 million people in Pakistan and over 80 million people worldwide.² The advent of automated computerized software has markedly enhanced the early diagnosis of glaucoma by facilitating precise detection of nerve supply to the retina fiber layer and pathologic damage to optic nerve head.³

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Glaucoma, primarily targets the intricate retinal ganglion cells (RGCs), which are large neurons characterized by dendrites forming synapses in the inner plexiform layer (IPL) with amacrine and bipolar cells within the retina.⁴ The ganglion cell layer (GCL) consists of the cell bodies of RGCs, while their axons collectively make up the retinal nerve fiber layer (RNFL), converging at the optic nerve head (ONH) to create the neuroretinal rim.⁵ Optical Coherence Tomography, initially introduced in 1991, initially exhibited lower reproducibility in its early iterations. Subsequent refinements addressed this issue, and for the evaluation of the optic nerve head, additional parameters such as neuro-retinal rim and (BMO-MRW) were introduced to enhance accuracy.⁶ The distance between ILM and opening of MRW offers a geometrically stable and more accurate assessment of the neuroretinal rim, contrasting with the less precise evaluation provided by ophthalmoscopy.⁷

This approach considers anatomical and geometrical aspects, incorporating the ONH-BMO-MRW topographic parameter.⁸ BMO-MRW offers an advantage in accurately representing neuro-retinal rim tissue orientation, with regionalized data relative to the axis between BMO and the fovea, enabling precise analysis.⁹ The study aims to identify which parameter

(MRW or RNFL) provides more reliable and accurate information in the context of glaucoma diagnosis. This information can contribute to refining diagnostic protocols and ultimately enhance patient care.¹⁰

METHODS

This descriptive cross-sectional study, approved by the institutional review board, was carried out at Ophthalmology department of Ghazi Hospital Dera Ghazi Khan from March 2022 to August 2022. The study aimed to determine the prevalence of glaucoma, which was found to be 69.03%. The sample size of 344 was calculated based on a sensitivity of 81.7% for the measurement of macular retinal thickness (MRW) at a fixed specificity of 95.7%, with a confidence interval of 95% and a desired precision of 5%. The study enrolled healthy individuals and those identified as glaucoma suspects based on criteria such as cup-to-disk ratio or elevated intraocular pressure exceeding 21 mmHg, who were attending the eye clinic at Ghazi Hospital in DG Khan. Inclusion criteria comprised participants of both genders, aged between 25 to 60 years. Exclusion criteria encompassed individuals with a history of ocular trauma, prior ocular surgeries like trabeculectomy or vitrectomy affecting the retina, evident ocular pathologies such as diabetes-related retinopathy and macular degeneration of older age, as well as neurological disorders like multiple sclerosis that could impact the structure of retina and normality of visual function pathways.

In this study, data was systematically collected using a pre-designed proforma, following the acquisition of informed consent. A comprehensive examination protocol was implemented, encompassing a detailed patient history, refraction with best-corrected visual acuity assessment, dilated funduscopy, slit-lamp examination, and tonometry. The diagnostic procedures involved the expertise of an experienced technician who conducted imaging, including spectral domain OCT utilizing Spectral GMPE software version 6.0, and an OCT machine from Heidelberg Engineering with version 2.0. Both eyes of each participant met the

eligibility criteria for inclusion in the study. In this study, confounders were controlled through strict adherence to inclusion and exclusion criteria. Diabetes and hypertension were identified as effect modifiers. Glaucoma status (positive or negative) based on MRW, RNFL, and optic disc cupping served as the outcome variable. SPSS Version 25 was utilized for data compilation and analysis. Diagnostic accuracy for MRW and RNFL, using cup-to-disk ratio as the gold standard, was determined. Post-stratification analysis assessed specificity, sensitivity, PPV, NPV, and diagnostic accuracy of MRW and RNFL, with stratification by age and gender to examine the impact of these modifiers on accuracy.

RESULTS

Overall, 300 patients were included in this study, with mean age 58.44±6.84 years. There were 218 (72.7%) males and 82 (27.3%) females. There were 61 (20.3%) patients diabetic and 161 (53.7%) patients were hypertensive. The mean cup to disk ratio was 0.57±0.17. (Table. I).

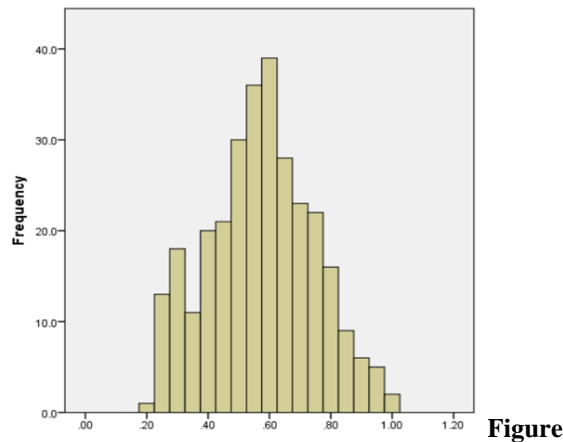
There were 289 (96.3%) patients diagnose with glaucoma by using cup to disk ratio, 256 (85.3%) diagnose with glaucoma by using RNFL and 263 (87.7%) patients diagnose with glaucoma by using MRW. The sensitivity, specificity, PPV, NPV and accuracy of RNFL and MRW with cup to disk ratio using as a gold standard were shown in table. II, with significant effect, (p<0.001) (Table. 2).

Table No. 1: Demographic and baseline variables of the study patients

Variable	N (%)
Sex	
Male	218 (72.7)
Female	82 (27.3)
Diabetes status	61 (20.3)
Hypertension	161 (53.7)
Cup to disk ratio	0.57±0.17
Mean±S.D	

Table No. 2: Accuracy measures of diagnosis of glaucoma cup to disk ratio with RNFL and MRW

		Cup to disk ratio		Total	p-value
		Positive	Negative		
RNFL	Positive	254 (99.2)	2 (0.8)	256 (85.3)	<0.001
	Negative	35 (79.4)	9 (20.6)	44 (14.7)	
Sensitivity	Specificity	PPV	NPV	Accuracy	
87.9%	81.8%	99.2%	20.5%	87.7%	
MRW	Positive	261 (99.2)	2 (0.8)	263 (87.7)	<0.001
	Negative	28 (75.7)	9 (24.3)	37 (12.3)	
Sensitivity	Specificity	PPV	NPV	Accuracy	
90.3%	81.8%	99.2%	24.3%	90.0%	



No. 1: Distribution of cup to disk ratio

DISCUSSION

Early diagnosis is important for controlling the progression of glaucoma, which is second leading cause of irreversible blindness globally. Various technologies have been developed to aid in early screening and prevent damage to optic nerve fibers¹¹. Quigley and Green in 1979, showed that optic disc cupping resulted from ganglion cell axon loss. Monitoring optic disc longitudinal diameter over time can reveal progressive damage before noticeable visual field loss occurs¹².

In this study sensitivity was 87.9%, 90.3%, specificity 81.8%, 81.8%, PPV 92.2%, 92.2%, NPV 20.5%, 24.3% and accuracy 87.7%, 90% of RNFL and MRW with cup to disk ratio using as a gold standard. In a study Chauhan et al¹³ found that while both BMO-MRW and RNFL thickness exhibited lower sensitivity overall, these parameters demonstrated increased specificity and sensitivity at 81% and 85%, respectively, particularly in cases of myopia exceeding 6 diopters; moreover, the researchers concluded that structural abnormalities in myopic eyes did not significantly impact the overall diagnostic performance of imaging devices.

Similarly, Khan et al¹⁴ reported that the sensitivity of retinal nerve fiber layer (RNFL) in diagnosing glaucoma was found to be smaller 86% than that of minimum rim width (MRW) 96.7%, whereas the specificity of both RNFL and MRW demonstrated a similar 77.8% performance. In a study conducted by Gondal et al¹⁵ reported that the mean retinal nerve fiber layer (RNFL) thickness demonstrated a sensitivity of 82% and specificity of 96%. When assessing the outcome of RNFL thickness, it is crucial to consider the age of the patient, as there is a progressive deterioration observed in the values of RNFL thickness with advancing age. Kim et al¹⁶ demonstrated that OCT detected retinal nerve fiber layer (RNFL) defects in early glaucoma cases, while in a similar study Leung et al¹⁷ found that OCT identified RNFL defects as

glaucoma progressed. Difference in time period of glaucoma development and its chronicity also matters. Parikh et al¹⁸ conducted a study in which they demonstrated that Stratus OCT (Optical Coherence Tomography) exhibited a sensitivity of 75% and specificity of 89.6% in diagnosing early glaucoma. The positive predictive value (PPV) was reported as 75%, indicating the probability of a positive test accurately identifying early glaucoma, while the negative predictive value (NPV) was notably high at 98%, indicating the reliability of a negative test result in ruling out early glaucoma. These findings underscore the diagnostic accuracy and utility of Stratus OCT, particularly in its ability to reliably exclude the presence of early glaucomatous conditions. Another author conducted a study on clinically detectable retinal nerve fiber layer (RNFL) defects, employing red-free photography, clinical examination, and automated visual fields in a cohort of 19 glaucoma patients and 14 controls, utilizing optical coherence tomography (OCT). The study yielded a sensitivity of 65% and specificity of 81% in establishing reliable results for detecting RNFL defects.

In the study conducted by Guedes et al¹⁹ a disparity was identified in the measured Retinal Nerve Fiber Layer (RNFL) thickness between the group of patients diagnosed with glaucoma and the cohort comprising individuals with normal ocular health. This discrepancy in RNFL thickness serves as a key indicator of structural variations in the retinal nerve fibers, potentially contributing valuable insights into the pathophysiology of glaucoma and highlighting the importance of such quantitative assessments in distinguishing between glaucomatous and normal eyes.

CONCLUSION

The diagnostic sensitivity for glaucoma is higher with retinal nerve fiber layer (RNFL) measurements compared to minimum rim width (MRW), but the specificity is equal for both. In myopic eyes, Bruch's membrane opening minimum rim width is comparable to RNFL thickness, making it a valuable diagnostic tool for identifying glaucoma in patients with myopic optic discs.

Limitations: Glaucoma prevalence and characteristics can vary among different ethnic groups and geographic locations. This study conducted in South Punjab region of Punjab, Pakistan so the study's findings might not be universally applicable if these factors are not taken into account.

Practical Implications: Clinicians can use the study results to educate patients about the diagnostic methods available for glaucoma detection, helping them understand the importance of regular eye examinations and the significance of specific measurements.

Author's Contribution:

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Drafting: Kamran Haider Shaheen,
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