Comparing Diagnostic Accuracy of MRW and RNFL in Detection of Glaucoma

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ABSTRACT
Purpose: To compare diagnostic accuracy of Bruch’s membrane opening minimum rim width (BMO-MRW) and Retinal Nerve Fibre Layer (RNFL) in detection of glaucoma taking cup to disc ratio as gold standard.

Study Design: Descriptive observational.

Place and Duration of Study: Liaquat National Hospital, Karachi from September 2017 to February 2018.

Methods: Total 344 participants including healthy and glaucoma suspect (according to the cup disc ratio or high intra ocular pressure more than 21 mmHg) were included. They were evaluated to compare diagnostic accuracy of MRW and RNFL taking cup to disc ratio as gold standard. Spectral domain OCT was performed. Sensitivity, specificity, and diagnostic accuracy of MRW and RNFL were calculated keeping cup-disc finding as gold standard.

Results: Mean Cup to Disk Ratio was 0.54 ± 0.10. Total 97.4% cases were diagnosed to have Glaucoma by Cup to Disk Ratio, 84.3% cases were diagnosed with Glaucoma by RNFL and 94.8% cases by MRW. By RNFL, 288 patients were true positive and 7 patients were true negative. Sensitivity, Specificity, and accuracy were 86.0%, 77.8%, and 96.2% respectively. The results showed that by MRW, 324 patients were true positive, and 7 patients were true negative. Sensitivity, Specificity, and accuracy were 96.7%, 77.8%, and 96.2% respectively.

Conclusion: The sensitivity of RNFL for diagnosis of glaucoma is higher than MRW. While the specificity of both RNFL and MRW was similar.

Key Words: Diagnosis, Mean Rim Width, Retinal Nerve Fibre Layer, Glaucoma.

INTRODUCTION
One of the irreversible causes of blindness in the world is Glaucoma.¹ There has been significant improvement in early diagnosis of glaucoma with the invention of automated computerized software for the analysis and detection of retinal nerve fibre layer and optic nerve head pathology.² Glaucoma affects retinal ganglion cells (RGC) that are complex large neurons with dendrites making synapses in the inner plexiform layer (IPL) with amacrine and bipolar cells of retina. Ganglion cell layer (GCL) is composed of RGCs cell bodies while their axons constitute retinal nerve fibre layer (RNFL) which merge at optic nerve head (ONH) to form neuro-retinal rim.³ Optical coherence tomography (OCT) was first described in 1991.⁴ Early attempts had lower reproducibility. However, for the assessment of optic nerve head another parameter including neuro-retinal rim and Bruch’s membrane opening minimum rim width (BMO-MRW) were proposed. Distance between inner opening of BMO to the internal limiting membrane (ILM) was measured. In contrast to ophthalmoscopy, it is geometrically...
more stable and provides more accurate evaluation of
neuro retinal rim.\textsuperscript{5}

Glaucoma Premium Module Edition software is
spectral-domain optical coherence tomography (SD-
OCT; Heidelberg Engineering GmbH) which includes
new inception of measurement of neuro-retinal rim,
anatomically and geometrically, taking new
topographic parameter of the ONH-BMO-MRW into
account. BMO-MRW provides advantage for the
orientation of OHN by correctly representing the
amount of neuro retinal rim tissue. Furthermore, the
acquired BMO-MRW data are regionalized relative to
the axis that lie between BMO and fovea of the eye
allowing its accurate analyses.\textsuperscript{6} Studies depict at 95%
specificity of both RNFL and MRW, the sensitivity of
RNFL and MRW is 70% and 81% respectively.\textsuperscript{7}

This study aimed to compare diagnostic accuracy
of RNFL and MRW using glaucoma premium
modules software on the basis of sensitivity and
specificity taking cup to disc ratio as gold standard.
Early detection of glaucoma is important to start
treatment before irreversible loss to the optic nerve
head fibres occurs which leads to blindness.

METHODS
This descriptive cross sectional study was conducted
in Liaquat National Hospital, Karachi from September
2020 to February 2021 after approval from
institutional review board. With prevalence of
glaucoma as 69.03\%, sample size was calculated by
taking sensitivity of MRW as 81.7\% at fixed
specificity of 95.7\% and confidence interval of 95\%
with desired precision of 5\%. The total sample size
was 344. Non-probability consecutive sampling was
used for this study.

Study participants included healthy patients and
glaucoma suspect (according to cup to disc ratio or
high intra ocular pressure of more than 21 mmHg)
attending the eye clinic at Liaquat National Hospital,
Karachi. Participants of either gender and age between
25 to 60 years were included. Persons with history of
any ocular trauma, previous ocular surgery e.g.
trabeculectomy, vitrectomy affecting retina, obvious
ocular pathology e.g. retinopathy related with diabetes
and age related macular degeneration and neurological
diseases including multiple sclerosis that affect retinal
structure and normal visual function pathway were
excluded. Data was collected on a pre-designed
proforma. Informed consent was taken. After detailed
history, examination was performed including
refraction with best corrected visual acuity, slit-lamp
examination, dilated Fundoscopy and tonometry with
Goldmann Applanation. Experienced technician
performed imaging and diagnostic procedure included
spectral domain OCT using Spectral GMPE software
version 6.0and OCT machine Heidelberg engineering
2.0. Both eyes were eligible for the study.
Confounders were controlled by strictly following
inclusion and exclusion criteria. Effect modifiers were
diabetes and hypertension. The outcome variable was
glaucoma (positive or negative) on the basis of MRW,
RNFL and optic disc cupping. Data were compiled and
analysed using SPSS Version 25. Frequency and
percentage were computed for qualitative variables
like gender, hypertension, diabetes mellitus, cup to
disk ratio, MRW and RNFL. Mean±SD were
calculated for quantitative variable i.e. age and cup to
disk ratio. Diagnostic Accuracy was computed for
MRW and RNFL keeping cup to disk finding as a gold
standard. Post stratification specificity, sensitivity,
positive predictive values (PPV) and negative
predictive value (NPV) along with diagnostic accuracy
of MRW and RNFL were calculated. The stratification
was done for gender and age to see the effect of these
modifiers on outcome i.e. accuracy.

RESULTS
Total 344 patients of either gender with age between
25 to 60 years meeting inclusion criteria were
evaluated to compare diagnostic accuracy of MRW
and RNFLT in detection of glaucoma taking cup disc
ratio as gold standard. The results showed 220 (64\%)
males and 124 (36\%) females. Mean age of the study
participants was 55.37 ± 4.23 years. The age was
further stratified in two groups. There were 15\% of
patients with less than or equal to 50 years and 85\% were
more than 50 years of age. There were 9.9\% diabetic
and 72.4\% hypertensive. Mean Cup to Disk Ratio was 0.54 ± 0.10.

There were 97.4\% cases who were diagnosed with
Glaucoma using Cup to Disk Ratio and 84.3\% cases
were diagnosed with Glaucoma by RNFL and 94.8\% cases
were diagnosed by MRW. Sensitivity, Specificity, Predictive values and diagnostic accuracy
of MRW and RNFL in detection of glaucoma taking
cup to disc ratio as gold standard were calculated.

The results showed that by RNFL, 288 patients
were true positive and 7 were negative with sensitivity,
Comparing Diagnostic Accuracy of MRW and RNFL in Detection of Glaucoma

The MRW stratification according to gender, age, Diabetes Mellitus, and hypertension was done and sensitivity, specificity, and diagnostic accuracy were also calculated, Detailed results are presented in Table 2.

The RNFL stratification according to gender, age, Diabetes Mellitus, and hypertension was done and sensitivity, specificity, and diagnostic accuracy were also calculated, Detailed results are presented from Table 3.

**Table 1:** Diagnostic accuracy of RNFL and MRW for diagnosis of glaucoma taking cup to disk ratio as gold standard.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
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<td>Age</td>
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<td>100%</td>
<td>100%</td>
<td>100.00%</td>
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<td></td>
<td>&gt; 50 years</td>
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<td>71.40%</td>
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<td>Gender</td>
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<td>83.30%</td>
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<td></td>
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<td>99.40%</td>
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<th>Variables</th>
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<th>PPV</th>
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<tr>
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<tr>
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<td>75.00%</td>
<td>95.50%</td>
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</table>
DISCUSSION

Glaucoma remains world’s second most significant cause of irreversible blindness. Early diagnosis is the key to control its progression and eventual damage to the optic nerve fibres. An increasing number of technologies have been introduced over time to assist in early screening for glaucoma. Retinal ganglion cells along with their axonal damage is the characteristic feature of glaucoma pathology. It not only leads to remodelling but also atrophy of the optic nerve head manifesting as narrowing of the neuro-retinal rim, excavation of nerve and lamina cribrosa appearing as lamellar dot sign.

In 1979, Harry Quigley and William R. Green, demonstrated that the optic disc cupping was caused by loss of axons of ganglion cells. Longitudinal evaluation of optic disc longitudinal diameter at different time points helps to identify progressive damage even in the absence of clearly defined visual field loss. RNFL measurement through SD-OCT is also helpful in detection of pre-perimetric stage of glaucoma.

Glaucoma Module Premium Edition is a software which allows enhanced 3-Dimensional Versus 2-Dimensional diagnostic capability of Neuro Retinal Rim parameters using SD-OCT. Investigators have proposed an anatomically and geometrically accurate neuro retinal rim parameters, which is one aspect of an OCT-based paradigm change in the clinical assessment of the optic nerve head. BMO-MRW parameter allows measurement of rim from outer border of neuro retinal rim, that is, BMO, which represents maximum optic nerve head aperture through which retinal ganglion cell axons pass. It provides accurate geometrical measurement, which measures minimum rim width from BMO to the internal limiting membrane not along or parallel to the fixed plane of the optic disc margin or BMO. Recent publications considered that BMO-MRW has a higher diagnostic and powerful association with visual field as compared to conventional rim parameters. Better assessment of optic nerve depth is provided by SD-OCT. Automated delineation software allows accuracy to delineate the anatomical landmark that is termination of Bruch’s membrane BMO. It provides superior assessment in myopia with tilted oblique insertion. Identifying glaucoma in myopic patient by both global and sectoral BMO-MRW showed better diagnostic performance than RNFL thickness. Both BMO-MRW and RNFL thickness had lower sensitivity, but for myopia exceeding 6D these parameters showed higher sensitivity and specificity at 85% and 81%, respectively. Overall diagnostic performance of imaging devices is not affected by the structural abnormalities in myopic eyes.

It was also noted that sectoral analysis of 6 sectors, for BMO-MRW performed better than RNFL thickness. The difference between glaucomatous eyes and control myopic eyes was better appreciated in inferotemporal sector while inferonasal sector showed statistical significance. One of the studies showed that mean RNFL thickness had sensitivity and specificity of 82% and 96% respectively. It is important to take into consideration age of the patient when evaluating outcome of RNFL thickness because progressive deterioration is seen in the values of RNFL thickness with increasing age. Kim et al. showed that in cases of early glaucoma, OCT detected RNFL defects while standard automated perimetry results were within normal limits. According to Leung et al. RNFL defects with the progression of glaucoma were picked up by OCT. The measurement of RNFL defect can provide an additional dimension for the measurement of glaucoma. The work of Blumenthal indicated that RNFL measurements by OCT were reproducible for both normal and glaucomatous eyes. Parikh et al. showed Stratus OCT had 75% sensitivity and 89.6% specificity for the diagnosis of early glaucoma with positive and negative predictive values of 75% and 98% respectively.

Pieroth et al. studied clinically detectable RNFL defects using clinical examination, red free photography, or automated Visual fields in 19 glaucoma patients and 14 controls using OCT. They establish the results with sensitivity of 65% only and specificity of 81%. Significant difference was found between measured RNFL thickness in glaucoma patients group and normal subjects in Guides et al study. In our study, we observed 77.8% sensitivity of both RNFL and MRW and specificity of RNFL and MRW as 86.0% and 96.7% respectively.

Limitation of this study was small sample size and single-centre study preventing generalization of results.

CONCLUSION

The sensitivity of RNFL measurements for diagnosis of glaucoma is higher than MRW. While the specificity of both RNFL and MRW was equal.
Bruch’s membrane opening MRW is similar to RNFL thickness for the identification of glaucoma in myopic eyes and offers a valuable diagnostic tool for patients with glaucoma with myopic optic discs.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board (App No. 0714-2019-LNH-ERC).

REFERENCES


Authors’ Designation and Contribution

Nazish Khan; Consultant Ophthalmologist: Concepts, Design, Literature Search, Data Acquisition, Data Analysis, Manuscript Preparation.

Munira Shakir; Professor: Design, Manuscript Editing, Manuscript Review.

Sahira Wasim; Consultant Ophthalmologist: Literature Search, Statistical Analysis, Manuscript Preparation, Manuscript Editing, Manuscript Review.

Salman Azmi; Resident: Literature Search, Manuscript Editing.

Shakir Zafar; Professor: Literature Search Statistical Analysis, Manuscript Review.