Original Article

Diagnostic Accuracy of Disc Damage Likelihood Scale and Cup-To-Disc Ratio for Diagnosis of Glaucoma

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ABSTRACT

Purpose: To find the diagnostic accuracy of Disc Damage Likelihood Scale (DDLS) and cup-to-disc ratio (CDR) for diagnosis of glaucoma taking central corneal thickness (CCT) adjusted intraocular pressure (IOP) and characteristic visual filed defects with corresponding OCT-ONH changes as standard.

Study Design: Comparative, cross-sectional.

Place and Duration of Study: Department of Ophthalmology, Mayo Hospital, Lahore, from August 2020 to February 2021.

Methods: Three hundred and nine patients were enrolled after taking informed consent. Demographic data was obtained and patients underwent complete ocular exam including DDLS and CDR, Slit-lamp biomicroscopy, gonioscopy and IOP. CCT, visual fields and OCT ONH was done. The patient was said to have glaucoma if his CCT adjusted IOP was greater than 21 mmHg, visual field defects and OCT changes. It was compared with CDR and DDLS, which was taken as suggestive of glaucoma with scores greater than 5.

Results: Mean age of patients was 54.82 ± 9.29 years, 108 (34.95%) were males. The sensitivity, specificity and diagnostic accuracy of DDLS for detection of glaucoma was 78.57%, 84.97% and 80.91% and the sensitivity, specificity and diagnostic accuracy of CDR for detection of glaucoma was 82.14%, 49.56% & 70.23% taking CCT adjusted IOP and characteristic visual field defects with corresponding OCT changes as standard.

Conclusion: DDLS is useful, cost effective and has higher accuracy to detect glaucomatous damage as compared to CDR for diagnosis of glaucoma taking CCT adjusted IOP and characteristic visual field defects with corresponding OCT changes as standard.

Key Words: Cup-to-Disc Ratio, Disk Damage Likelihood Scale, Glaucoma, Intraocular pressure.

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INTRODUCTION

Glaucoma is a blinding disease, timely diagnosis and proper management of which is a key to prevent its progression.[1] World Health Organization estimated those 4.4 million individuals worldwide were blinded by glaucoma, which accounted for 12.3% of all cases of global blindness.[1]

There are a number of diagnostic tests, which help in identifying glaucoma at an early stage. Fundus examination to see cup to disc ratio (CDR), intraocular pressure and retinal nerve fiber damage are some of the clinical tests for this purpose.[2,3] The distinctive appearance of the optic disc and the initial pattern of glaucomatous damage can affect diagnostic capability of OCT parameters in early-stage glaucoma. As a result, the ability of OCT parameters to diagnose glaucoma may vary based on the type of optic disc damage present.[4,5]

While the optic CDR is a key characteristic used in the diagnosis of glaucoma, it is prone to errors since it does not take disc size into account. To address this limitation, the Disc Damage Likelihood Scale (DDLS) was developed for assessing rim width that can enhance the accuracy of automated glaucoma diagnosis when used in combination with other features. By incorporating features such as blood pressure, age, and ethnicity into automated assessment techniques, the reliability of automated glaucoma diagnosis can be further improved.[6] Studies have reported that a DDLS score of greater than 5, which indicates glaucomatous damage to the optic nerve head, has a sensitivity of 74% and a specificity of 88%.[7] While sensitivity and specificity of CDR were 80% and 32.8% respectively for diagnosis of glaucoma.[8]

There is scarcity of local data regarding DDLS which also takes into account the disc size, this study was designed to compare DDLS and CDR for diagnosis of glaucoma in terms of sensitivity and specificity.

METHODS

It was a comparative study conducted at Department of Ophthalmology, Mayo Hospital, Lahore, from August 2020 to February 2021. Sample size of 309 cases was calculated with 95% confidence level, taking expected percentage of glaucoma i.e. 12.3%[2] and sensitivity of CDR i.e. 80% with 13% margin of error and specificity of CDR i.e. 32.8% with 13% margin of error.[8] Sample was collected through non-probability technique. Inclusion criteria comprised of patients between the ages of 16 and 70 years, either gender, family history of glaucoma, symptoms of constricted visual field or blurred vision. However, we excluded patients who had a history of recurrent glaucoma in the same or other eye, had cataract or retinal disease with serum creatinine levels greater than 1.3mg/dl, spherical errors greater than 5D or cylindrical errors greater than 2.5D, concomitant ocular disease with raised intraocular pressure, closed angles on gonioscopy, cloudy media which could impair fundus examination, history of ocular trauma or intraocular surgery.

The study enrolled 309 patients who met the selection criteria from the outpatient department (OPD) of the Department of Ophthalmology at Mayo Hospital in Lahore. All patients provided informed consent before participating in the study. Demographic information (name, age, gender, duration of symptoms, anatomical side and contact) was noted. Patients underwent complete ocular examination and disc measurements were recorded using DDLS and CDR with slit-lamp biomicroscopy (Haag-Streit slit lamp and Volk 90D lens) and gonioscopy was done using the Goldmann three-mirror lens. Goldmann Applanation Tonometry was used to take IOP. All measurements were recorded by the researcher. A trained ophthalmic technician conducted central corneal thickness measurements, OCT optic nerve head and 24 – 7 Humphrey visual field tests on the patients.

On the DDLS score chart, a value greater than 5 was considered positive, while a value of 5 or less was considered negative. Regarding the CDR (cup-to-disc ratio) observed during fundoscopy, a value greater than 0.5 was labeled as positive, while a value of 0.5 or less was labeled as negative. Glaucoma was confirmed if CCT adjusted IOP was greater than 21 mmHg, visual fields showed typical glaucomatous defects with corresponding findings on OCT optic nerve head. All the recorded information was documented on a proforma.

The collected data was analyzed using SPSS version 21. The quantitative variables, such as age and duration of symptoms were presented in the form of mean and standard deviation. Qualitative variables, including gender, anatomical side, glaucoma diagnosis based on DDLS, CDR, and ophthalmoscopy, were presented in the form of frequency and percentage. Two-by-two tables were created to calculate sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of DDLS and CDR, using ophthalmoscopy. Data was stratified by age, gender, anatomical side and duration of symptoms.

RESULTS

Mean age of the patients was 54.82 ± 9.29 years. There were 108 (34.95%) males and 201 (65.05%) females. There were 161 (52.10%) left eyes and 148 (47.90%) right eyes. Positive results on the basis of DDLS and CDR were 55.3% and 70.6% respectively. Out of 309 patients on CCT adjusted IOP and characteristic visual field defects, glaucoma were detected in 196 (63.43%) patients.

Sensitivity and specificity of DDLS for detection

of glaucoma was 78.57% and 84.97% taking CCT adjusted IOP and characteristic visual field defects with corresponding OCT changes as standard. With PPV of 90.06% and NPV of 69.57%, an overall diagnostic accuracy was 80.91% in detecting glaucoma.

Using the same standards, the CDR method showed a sensitivity of 82.14%, specificity of 49.56%, PPV of 73.85%, NPV of 61.54% and overall diagnostic accuracy of 70.23% for detecting glaucoma (Table 1).

Table 1: *Validity of DDLS and CDR for detection of glaucoma.*

		Glaucoma	Glaucoma on CCT Adjusted IOP and Visual Fields		Total
			Positive	Negative	
DDLS	Positive		154	17	171
	Negative		42	96	138
	Total		196	113	309
CDR	Positive		161	57	218
	Negative		35	56	91
	Total		196	113	309

For patients aged 50 years or younger, the DDLS demonstrated a diagnostic accuracy of 81.32% in detecting glaucoma and CDR showed 72.53%. Conversely, for patients older than 50 years, the diagnostic accuracy of DDLS was significantly lower at 12.41%. Using CDR, the diagnostic accuracy was 69.27%.

In patients with duration of symptoms of ≤ 12 months, the diagnostic accuracy of DDLS and CDR was 83.57% and 68.57% respectively. However, with duration of symptoms of > 12 months, the diagnostic accuracy of DDLS and CDR was 78.7% and 71.6% respectively.

The diagnostic accuracy of CDR for detection of glaucoma was 75.93% and 67.16% in males and females respectively.

DISCUSSION

The CDR is a commonly used clinical classification method for optic nerve head (ONH) evaluation in the diagnosis of glaucoma. However, its assessment is subjective and has fair-to-moderate inter- and intra-observer agreement, which can lead to errors in diagnosis. Additionally, the CDR does not take into account the size of the optic disc or the position of the cup, which can also affect the accuracy of the diagnosis.[9,10,11]

The DDLS is a useful tool for grading optic discs into different clinical stages, as it takes into account disc size and the position of rim thinning. It is a quantitative optic disc staging system that can be used in various clinical settings, including areas with limited resources. It is an inexpensive method that uses a slit lamp, which is readily available. By using the DDLS, clinicians can reliably grade optic discs and stage of glaucoma.[12]

The DDLS is primarily assessed through slit lamp, which is a cheaper and more readily available method than stereophotographs. While stereophotographs are more accurate and provide a more detailed view of the optic disc, they require specialized equipment and are more expensive to perform. As a result, the DDLS through slit lamp is a more practical and accessible method for grading optic discs in clinical practice, especially in resource-limited settings.[13, 4-16]

In this study the sensitivity, specificity and diagnostic accuracy of DDLS for detection of glaucoma was 78.57%, 84.97% & 80.91%. Similarly, the sensitivity, specificity and diagnostic accuracy of CDR for detection of glaucoma was 82.14%, 49.56% & 70.23%. Some of the studies are discussed below showing their results as.

The study conducted by Danesh-Meyer HV[13] demonstrated that the DDLS grading system performed favorably when compared to the CDR. Paying attention to both the disc diameter and rim width may enhance the clinical optic disc examination value.

A study has shown that when the DDLS score is greater than 5, which indicates the presence of glaucomatous damage to the optic nerve head, the sensitivity was 74% and the specificity was 88%.[7] The DDLS was found to have a significant and strong correlation with vertical (0.79) and horizontal (0.74) CDR, as well as with the parameters of vertical CDR and CDR area from HRT II (both 0.77) and TD-OCT (0.75 and 0.72, respectively).[7] The sensitivity and specificity of CDR for diagnosing glaucoma were 80% and 32.8%, respectively.[8]

Majid et al, showed that DDLS was a useful parameter in the diagnosis of glaucoma and it showed a close correlation with visual field, CDR and OCT parameters. Han et al,[18] found a strong correlation between DDLS and Cirrus OCT rim area (correlation

coefficient of -0.75), as well as with vertical CDR (correlation coefficient of 0.74).

The DDLS is a cost-effective and reliable method for diagnosing glaucomatous optic neuropathy with good inter- and intra-observer agreement and high accuracy. It also has strong correlations with CDR, standard automated perimetry and various types of optical coherence tomography measurements, including those from HRT, Cirrus, and Stratus. However, there is a learning curve associated with using this system, which is a potential limitation.[19,20]

Abdul Majid et al,[17] aimed to reduce selection bias by conducting a separate subset analysis in which the ONH rim thinning criteria was removed from the optic disc evaluation. The results showed no significant changes in correlations between the DDLS and the studied parameters, which included CDR, Stratus OCT parameters, and SAP MD index.

As not much literature is available on this topic, so it is suggested that in future further studies should be done with larger sample size to evaluate the findings of our study. It is also suggested that in future the study population should be taken from different centers rather than from one center.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval

The study was approved by the Institutional review board/Ethical review board **KEMU/66).**

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Author's Designation and Contribution

Sumbal Azeem; Consultant Ophthalmologist: *Concepts, Design, Literature Search, Data Acquisition, Data Analysis, Statistical Analysis, Manuscript Preparation, Manuscript Editing, Manuscript Review.*

Chaudhary Nasir Ahmad; Associate Professor: *Concepts, Design, Data Analysis, Statistical Analysis, Manuscript Preparation, Manuscript Editing, Manuscript Review.*

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