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Comparison of Optic Disc Parameters By Slit-Lamp Biomicroscopy and Optical Coherence Tomography

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ABSTRACT

Objective: To compare optic disc parameters by slit-lamp biomicroscopy and optical coherence tomography.
Study Design: Analytical cross-sectional study.
Place and Duration of Study: Department of Ophthalmology, PAF Hospital, Islamabad, Pakistan, from Jan to May 2023.
Methodology: The study was conducted on 100 eyes of 50 patients who underwent detailed refraction and dilated fundoscopy. Optic disc parameters were analyzed by a single clinician on a slit-lamp biomicroscope, while OCT images were assessed by a separate observer. Non-normally distributed continuous variables were summarized as median (interquartile range, IQR). Data was analyzed using SPSS version 24. Comparisons between clinician and OCT measurements were performed using the Mann–Whitney U test. A p-value ≤0.05 was considered significant.
Results: Overall, there were 32 males (64%) and 18 females (36%). The median age of participants was 22 years (IQR 11). Median RNFL thickness was 96 µm (IQR 12), and median intraocular pressure was 12 mmHg (IQR 2). Median (IQR) vertical and horizontal cup-to-disc ratios were 0.40 (0.20–0.50) and 0.30 (0.20–0.40) for clinician assessment, compared with 0.53 (0.42–0.64) and 0.61 (0.45–0.70) on OCT (Mann–Whitney U = 2843.5 and 1033, $p < 0.001$). Optic disc area was 3.06 mm² (2.82–3.29) for clinicians and 2.52 mm² (2.17–2.92) on OCT (Mann–Whitney U = 2160.5, $p < 0.001$). Axial length was 23.50 ± 1.20 mm.

Conclusion: Clinicians tend to underestimate cup-to-disc ratios on slit-lamp examination, while optic disc area may be slightly overestimated.

Keywords: Cross Sectional Analysis, Optic Disc, Optical Coherence Tomography.

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INTRODUCTION

Examination of the optic disc during a routine visit to eye clinic is an important undertaking to screen out any pathologies including glaucoma.[1] Early signs of glaucomatous damage to the nerve include increased cup-to-disc ratio, optic disc hemorrhage, optic disc notching, baring or bending of the vessels, and the laminar dot sign. Slit lamp examination is the basic tool for the assessment of the dimensions and health of the optic disc.[2]

Optical coherence tomography (OCT), on the other hand, is an objective way to examine the disc and can accurately calculate various dimensions of the optic disc.[3] The introduction of optical coherence tomography has greatly improved our understanding of the early changes encountered in glaucomatous damage. In the early 2000s, the OCT technology was largely replaced by spectral-domain tomography and hence is better at picking up progressive changes in glaucoma.[4]

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Khan SA et al conducted a study in North Devon District Hospital, comparing the optic disc parameters on slit-lamp (Subjective) vs on optical coherence tomography (Objective).[5] It was discovered that clinicians tend to underestimate their values on slit-lamp examination.[6] In another study conducted by Arnalich et al., a similar conclusion was madn.[7] The mean vertical as well as horizontal cup-to-disc ratios calculated by OCT were higher than those estimated by the clinicians.[8]

In a developing country like Pakistan, where OCT is not readily available, it is important to assess the difference between optic disc parameters seen on slit lamp and with OCT. The purpose of this study is to determine the mean differences in optic disc parameters (i.e., disc area and cup-to-disc ratios) on slit-lamp biomicroscopy and OCT of the optic nerve head (ONH).

METHODOLOGY

This study is an analytical cross-sectional study that was conducted at the Department of Ophthalmology, PAF Hospital, Islamabad, Pakistan,

from Jan to May 2023. Ethical approval was obtained from the ethical review committee of the hospital (Ref No 11142022 dated 14th Nov 2022). A total of 50 adult patients (100 eyes) were included using non-probability consecutive sampling. Informed consent was obtained from all participants. The sample size was calculated using the WHO sample size calculator, taking a confidence level of 95, a population proportion of 0.04, and a population standard deviation of 0.2.[9]

Inclusion Criteria: Adult patients of both genders between the ages of 18 and 60 years with visual acuity better than 6/24 on Snellen's chart. Only patients with good quality images on the OCT were included in the study.

Exclusion Criteria: Patients with media opacities, refractive errors of -6.0 D or more, +4.0 D or more, astigmatism of more than 2 D, tilted discs, and disc swelling were excluded from the study.

After obtaining ethical approval, patients were selected through nonprobability consecutive sampling. Consent was obtained from all the participants. Patients underwent a detailed history-taking process, visual acuity measurement, refraction (subjective and objective), slit lamp examination, ocular tonometry, and fundus examination. All patients were examined by a single clinician.

Subjective parameters were calculated by adjusting the beam of the Slit-Lamp (Nidek SL-450) until it matched the distance between superior and inferior limits for vertical optic disc diameter and nasal and temporal limits for horizontal diameter. Both vertical and horizontal diameters were recorded in millimeters. The correction factor was applied for the lens used (1.50 for Volk Super Field). The cup-to-disc ratio was calculated by comparing the central cup with the optic disc diameter in the vertical dimension. Optovue ISCAN80 (Model iVue500) was used for objective automated assessment of optic disc parameters and was carried out by a single observer.

Collected data were entered and analyzed through Statistical Package for Social Sciences (SPSS version 24). Non-normal continuous variables like age, retinal nerve fiber layer thickness, and intraocular pressure were reported as median (IQR). Comparison between clinician-observed and OCT measurements was performed using the Mann–Whitney U test (p-value < 0.05). The only normally distributed variable (axial length) as mean and standard deviation, using a paired t-test, with a p-value ≤0.05 taken as significant.

RESULTS

A total of 50 patients were enrolled in the study, and both eyes were used for data analysis. Overall, there were 32 males (64%) and 18 females (36%). There were 38 patients (76%) in the age group of 18-30 years, 5 patients (10%) in the age group of 31-45 years, and 7 patients (14%) in the age group of 46-60 years. The anatomical sides were right in 50 patients (50%) and left in 50 patients (50%). 50 eyes (50%) were emmetrope, 35 eyes (35%) were myopic, and 15 eyes (15%) had astigmatism. There were no hypermetropies in the study. (Table-I).The median age of participants was 22 years, IQR 21(Q1-Q3:19-40). Median RNFL thickness and intraocular pressure were 96 µm, IQR 12(Q1-Q3:88-100), and 12 mmHg, IQR (Q1-Q3:11-13), respectively (Table-II).

Table-I: Demographic Characteristics

Demographic characteristics	Frequency (%)
Patients (n=50)	
Male	32(64%)
Female	18(36%)
Eyes (n=100)	
Left	50(50%)
Right	50(50%)
Refractive error	
Emmetropia	50(50%)
Myopia	35(35%)
Hypermetropia	Nil
Astigmatism	15(15%)

Table-II: Clinical Measurements (Non-Normal variables)

Parameter	Median (Q1-Q3)
Age (years)	22.0 (16.5-27.5)
RNFL thickness (µm)	96.0 (90.0-102.0)
Intraocular pressure (mmHg)	12.0 (11.0-13.0)

**RNFL - Retinal Nerve Fiber Layer*

Clinician-estimated vertical and horizontal cup-to-disc ratios had median (IQR) values of 0.40 (0.2–0.5) and 0.30 (0.2-0.4), respectively, compared with 0.53 (0.42–0.64) and 0.61 (0.45–0.70) measured by OCT. The differences were statistically significant with Mann–Whitney U values of 2843.5 for vertical cup-to-disc ratios and 1033 for horizontal cup-to-disc ratios (p < 0.001 for both).Optic disc area was slightly overestimated by clinicians, with a median (IQR) of 3.06 mm² (2.82–3.29) compared to 2.52 mm² (2.17–2.92) on OCT (Mann–Whitney U =2160.5, p < 0.001) (Table III). Axial length was normally distributed and had a mean of 23.50±1.20mm.

DISCUSSION

In our current study, the mean vertical CDR, mean horizontal CDR, and optic disc area estimated

by clinicians were 0.38±0.04, 0.31±0.02, and 3.11mm2 ± 0.1mm2 respectively, and those assessed by the OCT were 0.53±0.04, 0.60±0.04, and 2.59mm2± 0.3mm2 which shows that the clinicians underestimated the measurements. The results of the study are like a study by Khan et al., where the mean vertical CDR was 0.56 ±0.03mm. This study highlighted that clinicians usually underestimate optic disc parameters such as vertical and horizontal CDR. The strength of agreement in the study was calculated as 0.77 for vertical disc diameter and 0.70 for vertical CDR. This is very similar to what we found in our study, where the disc was underestimated subjectively as well.[10]

Table-III: Optic disc parameters (Clinician vs OCT)

Parameter	Clinician Median (Q1-Q3)	OCT Median (Q1-Q3)	Mann–Whitney U test	*p*-Value
Vertical CDR(VCDR)	0.40 (0.2-0.5)	0.53 (0.42-0.64)	2843.5	<0.001
Horizontal CDR(HCDR)	0.30 (0.2-0.4)	0.61 (0.45-0.70)	1033.0	<0.001
Optic disc area(mm2)	3.06 (2.82-3.29)	2.52 (2.17-2.92)	2160.5	<0.001

**CDR - Cup-to-Disc Ratio, HCDR - Horizontal Cup-to-Disc Ratio, OCT - Optical Coherence Tomography*

Dilated fundoscopy is an essential part of a complete ophthalmic examination. The examination of the optic nerve and its various parameters is essential for assessment of glaucoma and its management.[11] It is a well-known fact that structural damage of the optic nerve precedes the visual field defects. OCT has been regarded as a first-line investigation for viewing structural damage related to glaucoma.[12] Literature has established the credibility and reproducibility of OCT in measuring the various optic nerve disc parameters and the measurement of the retinal nerve fiber layer. Optic nerve parameters have been evaluated in previous studies using different machines, including HRT, Cirrus HD-OCT, Spectralis OCT, RTVue-100 etc.[13]

A very recent study conducted by Vats et al., on Indian population has similar outcomes. The vertical CDR is significantly underestimated on slit lamp biomicroscopy compared to OCT measurements.[13] Similarly, another study by Singh *et al.,* supported the evidence of clinicians underestimating various optic disc parameters. The mean OCT reading for vertical cup-to-disc ratio was higher as compared to the clinicians, varying between 0.11 – 0.18. The same results were documented for the horizontal cup-to-disc ratio, where the clinicians again underestimated the value, with the difference ranging between 0.25 – 0.32. It was also observed in the study that the OCT had higher values for both vertical and horizontal CDR when the cup was smaller than 0.7, meaning it is easier to estimate a larger cup than a smaller cup when doing a clinical examination. The reason for this outcome could be not considering the magnification factor of the indirect lens.[14]

On the contrary, a study conducted by Perera *et al.,* found that the optic disc parameters were almost like what they found on OCT. Their study used the Disc Damage Likelihood Scale to assess the optic disc parameters, and this could be the reason for the stronger correlation with the OCT findings.[15] Various methods of optic disc assessment have been employed to assess its dimensions. When using the slit-lamp, condensing lenses of various powers, namely 60D, 78D, and 90D, have been employed to visualize the fundus and the optic disc. A 60D lens was used to assess various optic disc parameters, which resulted in a better correlation than when using a 90D lens (r = 0.80 with 60D and r = 0.59 with 90D).[16] The correlation and agreement of horizontal and vertical CD ratios are strong in our study, where we employed a Superfield lens for our clinical assessment and an RTVue OCT machine. This contrasts with another study by Watkins *et al.,* where poor correlation and agreement were established using OCT, HRT-3, and clinical grading.[17]

In a study by Jeong *et al.,* various parameters of the optic disc, such as optic disc size and the CDR, were calculated and compared by spectral domain OCT (SD-OCT) and HRT. Their study also found that HRT overestimated the parameters, especially the optic disc area, as compared to SD-OCT.[18] In our study, we used OCT by Optovue for objective assessment of the optic disc, which also resulted in overestimation of the optic disc parameters.

Previously conducted studies have used other modes of quantitative and qualitative assessment of the optic disc. Watkins et al., found that when assessing these parameters using a slit-lamp or the direct ophthalmoscope, both these modalities underestimated the parameters compared to HRT.[17] Numerous other studies have also compared clinical optic disc analysis with other semi-automated methods, and the results were always conclusive that there was clinical underestimation of these parameters on indirect ophthalmoscopy, especially when compared with HRT and ImageNet System. This is what we found in our study as well. Clinical measurement with a Goldmann three-mirror lens in 158 eyes differed from planimetry by 9.4% ± 6.6%. A

newer study found RNFL thickness more useful than optic nerve head parameters for glaucoma diagnosis.[19]

No other comparative study had been done to compare optic disc area on slit-lamp and OCT in Pakistan, making these findings locally relevant. By assessing vertical and horizontal CDR and optic disc area with Optovue OCT, this study informs clinicians working without OCT, although its single-center, small-sample design limits generalizability. The results confirm that slit-lamp examination tends to underestimate CDR, especially in smaller cups, and slightly overestimate optic disc area. Median (IQR) reporting and nonparametric testing appropriately represented the non-normal data.

LIMITATION OF STUDY

This study was conducted at a single center and included a relatively small sample of 50 participants (100 eyes), which may limit the generalizability of the findings to broader populations and different clinical settings. In addition, both eyes of each participant were included in the analysis; therefore, the potential correlation between fellow eyes should be considered when interpreting the results. The cross-sectional design also precluded evaluation of longitudinal changes or the ability of either method to detect disease progression. Future multicenter studies with larger, more diverse samples, probability-based recruitment, repeated measurements by multiple observers, and statistical methods that account for within-subject inter-eye correlation are recommended to validate these findings and improve their external validity.

CONCLUSION

Clinicians tend to underestimate vertical and horizontal CDR on slit-lamp biomicroscopy. Optic disc area may be slightly overestimated. Reporting median (IQR) and using the Mann–Whitney U test provides a robust and accurate analysis of non-normal ophthalmic measurements. In conclusion, there was a strong agreement between clinical estimation of optic disc parameters and their OCT counterparts at greater CDR's and disc areas. At lower values, clinicians seemed to underestimate the actual disc size and its parameters.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

RM& MAK: Data acquisition, data analysis, critical review, approval of the final version to be published.

AS & HZ: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

IA & MS: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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