Comparison Of Results Of Optic Disc Analysis Using Stereoscopic Biomicroscopy, Stereo Fundus Photography and Optical Coherence Tomography

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Abstract
Aim – To compare the results of optic disc analysis using optical coherence tomography, fundus photography and stereoscopic biomicroscopy.

Materials & Methods – A comparative, observational case series and interobserver variability study in which 2 groups of patients were analysed by all the 3 methods. One group had primary open angle glaucoma patients and the other group were patients undergoing retinal evaluation. Stereo fundus photography and stereo biomicroscopy were performed using 90D lens while optical coherence tomography was performed using stratus OCT after dilating the pupil.

Results – 50% cases showed good correlation between all the 3 methods. Optical coherence tomography showed a higher value indicating the requirement to do optical coherence tomography in all patients to detect the actual cup disc ratio which will help us to detect glaucoma cases earlier and to treat them, well before axonal loss occurs. The optic disc analysis results were confirmed by two people who assessed the optic disc separately to avoid the inter observer bias.

Key words : Cup-disc [CD] ratio, Vertical CD Ratio[VCDR], Optical Coherence Tomography[OCT], Slitlamp biomicroscopy, glaucomatous optic neuropathy.

Introduction
Optic nerve head evaluation is the hallmark of glaucoma diagnosis. Structural alteration of optic nerve head precedes the development of reproducible glaucomatous visual field defects. Retinal ganglion cell population at any retinal locus may be reduced by 50 % before this can be detected using conventional perimetric techniques. Therefore identification of these changes is important in early diagnosis of glaucoma.

Fundus biomicroscopy enables more accurate, less variable Vertical Cup Disc Ratio (VCDR) estimation than direct ophthalmoscopy. Until recently clinical assessment of optic nerve head with biomicroscopy has been the standard practice for diagnosis of glaucomatous optic neuropathy. It varied between experienced observers and subtle changes over time are difficult to detect clinically. It is best done stereoscopically either by the indirect method with +78 or +90 D lens, the latter being more popular or with contact lenses like the Central part of Goldmann or Zeiss 4 mirror gonioscope.
Monochromatic photographs of retinal nerve fibre layer using the red free light have been also used to detect the retinal nerve fibre loss. Digital photography of the optic nerve head also is useful. Various methods to quantitatively and objectively assess the optic nerve head have evolved in the last decade for e.g. confocal scanning laser ophthalmoscopy (CSLO), scanning laser polarimetry (SLP), optical coherence tomography (OCT) and stereoscopic colour photographs (ONHPs).

In this study we are comparing the optic nerve head evaluation by stereoscopic colour photographs (ONHPs), stereo biomicroscopy (SBM) and optical coherence tomography to find the accuracy, reliability and usefulness of each in glaucoma practice. Optical coherence tomography has wider uses in retinal diseases as well, and is more likely to be available in a clinic than the others which will be available in institutional practices, thus has been chosen as the quantitative method for optic nerve head evaluation in the study. As of now although the measurements of the various optic nerve head parameters is available but normative data has not been made available in the Stratus IV optical coherence tomography, but the normative data for retinal nerve fibre layer measurements is available. Stereophotography uses a specialized camera to take a pair of photographs of the optic nerve, which when seen with a specialized viewer, create a three dimensional (3-D) image. It may be slightly modified to make it easier to see the optic nerve fibers.

OCT is a non-contact, noninvasive diagnostic technique showing a cross sectional living histology of retina 4,5,6. It is a high resolution reproducible imaging technology, which is increasingly being used in evaluation of glaucoma patients. It uses low coherence near infrared light (850 nm) from a super luminescent diode and subsequent back scattering of the retina 7. It generates, posterior segment measurements with an axial resolution of 8-10 microns.

Patients and Methods

This is a prospective observational study conducted at Amrita Institute of Medical Sciences wherein we compared two groups of patients. Group I included patients of primary open angle glaucoma who came for their regular follow up. Group II included nonglaucoma patients who came for routine ophthalmology check up for minor refractive errors.

We evaluated both eyes of 15 patients in each group. An informed written consent was taken from each subject.

All patients with a best corrected visual acuity better than 20/30 were chosen. Their refractive errors were between −3 and +3 dioptres of sphere or between −3 and +3 dioptres of cylinder, with no ocular disease other than glaucoma.

The Cup-Disc[C/D] ratio was noted in both vertical and horizontal meridians for each patient by each of the three methods. Optic nerve head assessment was done after dilating all the patients with 0.8 % tropicamide and 5 % phenylephrine eye drops. We assessed optic nerve head by [A]slit lamp biomicroscopy using a + 90 D lens. The horizontal and vertical cup disc ratios were assessed. [B] A fundus non stereo digital image using Zeiss VISUPAC fundus camera FF 450 was taken for each patient. The margins of optic cup and the optic disc were marked after loading in 1-image split view mode. The cup and disc were circumscribed as two separate areas using the Closed Polygon or Free-hand contour function. Then using the measure mode in the VISUPAC software, the cup-disc ratio in the horizontal and vertical meridians were noted.

This was done by clicking on the end of line and holding the mouse button depressed and dragging it in the desired position. Additionally, the following parameters are displayed: cup and disc area in mm$^2$ and the linear C/D ratio for the total papillae in percent. For vertical meridian, an average of C:D ratio at 90 and 270° were taken, and for horizontal meridian an average of CD at 0° and 180° were taken. The corresponding C/D ratio data are displayed at the intersecting points of the radial lines. With change in the size of the drawn figures, the data are automatically updated.

To do this, click on the end of line and holding the mouse button depressed drag it in the desired position. Additionally, the following parameters are displayed: cup and disc area in mm$^2$ and the linear C/D ratio for the total papilla in percent.

[C]Evaluation on OCT was done using the Fast Optic Disc Protocol on the Zeiss Stratus OCT Model 3000. It analyses optic disc with a circle of 4 mm diameter.
around optic nerve head. Six radially acquired cross sectional line scans spaced 30° apart were done that were passing through the centre of optic nerve head. The horizontal and vertical cup disc ratio was given by the software in this method.

Optic disc analysis by fundus photograph, OCT and biomicroscopy were done by two experienced observers to avoid the interobserver bias.

Statistical methods (Pearsons Correlation and Kappa) were applied to study the significance of the difference in the CD ratio as calculated by the 3 methods.

**Results**

In Group I the age was between 48 to 76 years [Mean 59.6 years], and in Group II between 20-65 years [Mean 52.3 years]. Group I had 7 males and 8 females and Group II had 6 males and 9 females. For each of the patients the Cup Disc ratio was noted by all the three ways in both the eyes. In three patients of Group I the optic disc could not be assessed due to media opacity. Fig.1[A] depicts the CD ratio in both the vertical and horizontal meridian for each of the patients in Group I with fundus photography; Fig.1[B] depicts the CD ratio in both the vertical and horizontal meridian for each of the patients in Group I with Slitlamp biomicroscopy; and Fig.1[C] depicts the CD ratio in both the vertical and horizontal meridian for each of the patients in Group I with OCT.

Vertical CD ratio calculated by OCT was the highest in 90 % of glaucoma patients and in 60 % of the control group. In the normal population CD ratio as calculated by slitlamp biomicroscopy was the least.

Relationship between CD ratio as calculated by the 3 methods was compared both for horizontal & vertical CD ratios separately taking 2 modalities at a time by Pearson correlation i.e. OCT and SBM; OCT and ONHPs; then ONHPs and SBM.

ONHPs and OCT did not correlate well with each other both for the vertical & horizontal CD ratio[Fig. 2]. However, horizontal CD ratio by OCT and biomicroscopy correlated better. SBM had a good correlation with OCT & ONHPs in the Vertical axis. Vertical CD ratio is either way more clinically relevant for glaucomatous damage. Visualisation of vertical cup is affected less by disc vessels and their branching and thus is more accurately calculated. Intra class correlation which was used to assess the relationship of all the 3 methods together was 84 % for vertical & 69 % for horizontal axis. Inter observer correlation was done with kappa for ONHPs and SBM and showed 60 % correlation. [Fig. 3a and 3b].

**Discussion**

Glaucoma is now recognized as an optic neuropathy and not merely a disease with raised intraocular pressure. Assessment of the optic nerve head is essential for diagnosis, management and progression of the disease. With a plethora of modalities available for assessing the optic nerve head we need to know which is more reliable, which has better sensitivity and specificity and which of them is more reproducible. Various studies have tried to find the most appropriate
The normal distribution of the Neuroretinal rim follows the ISNT rule being the thickest at the Inferotemporal sector [83 % eyes], followed in decreasing order by Superotemporal, Nasal and temporal. It is the vertical cup that correlates best with glaucomatous damage, we should record the cupdisc ratio in horizontal and vertical meridian. The large physiological cups in large discs appear round.

Clinical evaluation by SBM & ONHPs are subjective methods. They have an interobserver bias and it may not be reproducible at a later date. OCT on the other hand is objective; it picks up the measurements depending on the reflectivity change at the RPE level corresponding to the scleral margin of the disc and the optic cup is picked up by the change in reflectivity at retinal nerve fiber layer. Both these are morphological determinants for ganglion cell loss which is reflected by the CD ratio. On reliability analysis scale, CD ratio
for the same patient was higher with OCT than with the other two methods.

We need to follow up the normal patients with high CD ratio on OCT to see if they convert to glaucoma as evidenced by visual field changes or high intraocular pressure. We also need to exclude nonglaucomatous reasons of optic disc cupping like ONH coloboma, optic pit.

ONHPs is a tedious method. OCT may overestimate the CD ratio, but is user friendly with easily interpretable and reproducible data. We also need to compare the RNFL loss in OCT for the same patient. Variability in size & appearance of ONH of normal eyes accounts for the difficulty in detecting the presence of early glaucomatous optic nerve damage.

Accurate measures of CD ratio may be derived from OCT images of images the ONH. The disc width was defined as the separation of the terminations of the retinal pigment epithelium on each side of the image. Estimates of clinical CD ratios in normal subjects appear to be less than those with OCT.

50 % cases showed good correlation between all the 3 methods. Optical coherence tomography was showing a higher value indicating the requirement to do optical coherence tomography in all patients to detect the actual cup disc ratio, this will help us to detect glaucoma cases earlier & to treat them well before axonal loss occurs.

In one study of Hynchak, where the CD ratios by both digital Photography and stereobiomicroscopy were compared CD ratio estimation on photos showed a lesser value in normal subjects. This study suggested that caution should be exercised when using stereoscopic and non-stereo digital evaluations of CD ratio interchangeably to assess longitudinal progression in a multi-clinician setting.

The mean optic disc parameters with the 95 % confidence intervals for the distribution of normal optic disc parameters in South Indian population as suggested by a study by Sekhar et al were: disc area 3.37 mm$^2$ (2.04 - 4.7), vertical disc diameter 2.12 mm (1.67 - 2.57), vertical cup to disc ratio 0.37 (0.19 -0.55) and neuroretinal rim area 2.8 mm$^2$ (1.76 - 3.84).

The optic disc analysis results were confirmed by 2 people who assessed the optic disc separately to avoid the inter observer bias. Some studies suggest that VCDR adjusted for vertical optic disc diameter may assist in the diagnosis of glaucoma in clinical practice. Correnti et al suggested that there was no statistically significant difference between techniques with respect to sensitivity and specificity of glaucoma detection, as far as optic nerve head (ONH) measurements and glaucoma status is concerned.

Fundus biomicroscopy enables more accurate, less variable VCDR estimation than direct ophthalmoscopy.

**Conclusion**

Optic nerve head evaluation is paramount for glaucoma diagnosis and it should be recorded separately in the vertical and horizontal meridian. The clinician should record which of the methods they used to examine the optic nerve head i.e. slitlamp biomicroscopy, ophthalmoscopy, OCT, HRT or digital fundus photograph so that subsequent clinical decisions are not influenced by apparent VCDR changes. In our study 50 % cases showed good correlation between all the 3 methods. Optical coherence tomography was showing a higher value.

**References**


