Original Article

An innovative and simple method, clinically comparable to high-definition optical coherence tomography in quantifying posterior segment lesions in the retina

Shaji P Koshy, Leena Mariyam Varghese, Satish Thomas, Pramod Thomas[1]

Purpose: To introduce a simple and inexpensive method using a fundus contact lens and a reticle, to measure retinal lesions comparing it with values obtained with high-definition optical coherence tomography (HD-OCT). This study considers optic disc as the object for comparison. **Methods**: Patients underwent routine ophthalmologic examination and their horizontal optic disc diameter was measured, both with the reticle and OCT. For measurement with reticle a simple equation was deduced, x = 0.7y, where *x* corresponds to the actual image size and *y* to the reticle scale reading in millimeters. **Results**: An aggregate of 127 eyes of 75 patients were dilated and examined. The calculated mean diameter according to OCT was 1.639 mm (standard deviation = 0.179) and that assenting to reticle was 1.713 mm (standard deviation = 0.175), with a difference in mean being 0.089 mm. **Conclusion:** Values obtained by this new method was found to be comparable with the OCT values for retinal measurements, useful for ophthalmologists who cannot afford expensive and sophisticated machines.

Key words: HD-OCT, OMRA-S Mainster focal/grid lens, optic disc diameter, reticle

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Evaluating the size of lesions or structures in the fundus is clinically important for diagnostic and prognostic purposes. Of the diverse methods that have been sorted for measurement, the most simple and practical is the one which Walling and Denardo described with an ophthalmoscope, known as the "disc diameter" which can not only measure the size of a lesion but can also express the distance of lesion from the disc.[1] Alfred Cowan put forth the use of perimetry in measuring the size of the lesion by analyzing the scotoma a lesion can produce.[2] Morgan, in his studies to measure the size of a fundus structure, incorporated a graticule into the optical system of a handheld Keeler Ophthalmoscope.[3]

In this study, a simple fundus contact lens and a reticle are used for a quick and easy measurement of anything in the posterior fundus. The optic disc is considered as the object for measurement and the values were compared with high-definition optical coherence tomography (HD-OCT) readings. The normal optic disc size varies between 1.2–2.5 mm.[4] Various methods have been described in many studies to measure disc size using condensing lenses.[5,6] More sophisticated and expensive devices such as stratus optical coherence tomography (OCT), computerized digital image analyzer, confocal scanning laser ophthalmoscopy (CSLO), and scanning laser polarimetry (SLP) that give refined results,[7,8] are not easily available in all centers, hence, the need of increasing such simple techniques for ophthalmologists in remote areas.

Methods

This is a prospective observational study conducted at the Ophthalmology Department of a tertiary care center after obtaining ethical permission from the institutional ethical committee. The methods applied in the study adheres to the tenets of the declaration of Helsinki for the use of human subjects in biomedical research.

All the patients visiting the outpatient department of ophthalmology underwent a routine ophthalmologic examination. Cooperative patients with a steady gaze, emmetropic or ametropic not more than 2 diopters, clear media, and sharp disc margins were included in this study. Patients who were uncooperative, having an unsteady gaze, with high refractive errors, hazy media, and discs with blurred margins, peripapillary atrophic changes, and tilt were excluded. In OCT measurement, a signal strength of ≤6 and an incorrect axial alignment that may truncate the disc margins were also excluded.

The routine examination included best-corrected visual acuity, intraocular pressure measurement, distant direct ophthalmoscopy, and a slit-lamp examination to rule out media opacities. After an anterior segment evaluation, the eyes were dilated with 0.8% tropicamide and 5% phenylephrine

Department of Ophthalmolgy, Believers Church Medical College Hospital, [1]Department of Community Medicine, Believers Church Medical College Hospital, Kuttapuzha, Thiruvalla, Kerala, India

Correspondence to: Dr. Leena Mariyam Varghese, Department of Ophthalmology, Believers Church Medical College Hospital, St Thomas Nagar, Kuttapuzha, Thiruvalla - 689 103, Kerala, India. E-mail: leenalincy.varghese@gmail.com

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drops. The post-dilated examination was performed on a slit lamp (standard model by Zeiss with 10X magnification eyepiece and a three-step magnification in the console) with a 78D condensing lens to assess disc margin. For measuring the optic disc size, the following were used:

1. Fundus contact lens (OMRA-S Mainster focal/grid lens, by ocular Instruments, USA) with a magnification of 0.96X and 90-degree field of view
2. Micrometer (manufactured by Carl Zeiss Germany): a standard Zeiss classic 115 slit-lamp 10X eyepiece into which a linear and angular scales are incorporated [Fig. 1]
3. Cirrus OCT (by Carl Zeiss Germany): a high definition OCT employed in measuring the size of the disc en-face with the built-in calipers.

The horizontal disc diameter is measured en-face in disc-retinal nerve fiber layer (RNFL) scan protocol thrice and averaged as Cirrus HD-OCT does not provide disc-diameter measurement among a series of optic-disc parameters it portrays. For this, although a non-dilated pupil can deliver excellent picture quality with an HD-OCT, pupils are dilated as for further evaluation of discs with a contact lens, as it is demanded. Patients are encouraged to blink a few times immediately before scan capture to ensure uniform tear film distribution and to preserve adequate scan quality. This also improves patient comfort, thus decreasing the likelihood of blinks or motion artifacts that can distort the margins of the disc.[9] Vertical poles of the disc may not be as sharp as horizontal due to the relative increase in RNFL crowding, hence, measurement of the horizontal disc margin is preferred. The measurement is taken at the anterior-most level and not at the level of Bruch's membrane as this plane correlates better with the plane on the retina where the reading is performed with the reticle. Only good-quality scans (defined as scans with signal strength of at least seven and no missing parts within the measurement circle and no motion artifacts) were used for analysis. The measurement of the disc is then performed with the micrometer on a slit-lamp and a fundus contact lens.

This study accommodates the use of a reticle in conjunction with a Zeiss slit-lamp. The reticle has both an angular scale and linear scale and the latter will be used for length measurement that will be employed in the evaluation of disc. The linear scale is divided into 15 scale units which are in millimeters and each scale unit being subdivided into 5 scale divisions with 1 scale division = 0.2 mm. The measurement of length is done after substituting an eyepiece of the slit-lamp with the one having the micrometer incorporated within [Fig. 2]. The preferred magnification that is recommended is 12X on the slit-lamp console. After applying viscoelastic substance on the corneal side of the lens, the ocular Mainster focal/grid laser lens is placed on the cornea without trapping any air bubble. A short slit-lamp beam is used to minimize back-scattered slit-lamp light that can decrease image contrast. The readings are taken thrice and the average is tabulated after applying the correction and magnification factors.

The principles in calculating the size of retinal landmark [Fig. 3]

1. A landmark that has to be quantified whose size is "x" is observed through the contact lens employed in this study
2. The image of the object falls in front of the contact lens and a minimal change in size has taken place due to the magnification factor of the lens which is 0.96. The size of the image here has become 0.96X on applying the correction factor
3. As for the reticle, this image forms the object and a final image is formed at the observer's end of the eyepiece. Let the size of this image be "y."

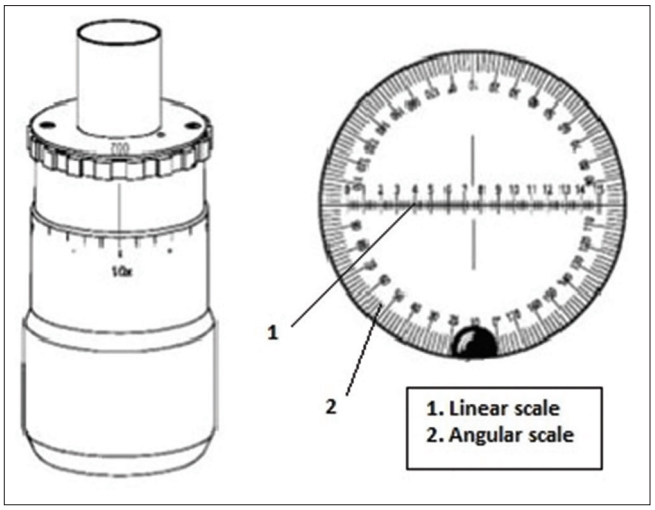

Figure 1: Micrometer eyepiece (schematic diagram)

Now, on carefully observing the facts laid above, the deductions are:

"x," the actual size of the image, when observed through the contact lens with a magnification factor of 0.96, has undergone a change in size to 0.96X . This new image that falls between the contact lens and the eyepiece, when observed with the reticle incorporated eyepiece is found to have a change in size to "y." As described in the user's manual for Classic SL 115 Zeiss slit-lamp, the corrected size of the image (here 0.96X), when observed through the reticle with 12X magnification, will be the observed image size multiplied with 0.671. Thus, we can arrive at a simple equation:

$0.96x = 0.671y$ *or* $x = 0.671y/0.96$ *Or*

$x = 0.6989583333333y \approx 0.7y$.

As y is always known, which is the reticle reading, the actual size of the fundus landmark is equal to the product of the observed reading and the constant 0.7.

Thus, a simple working formula x = 0.7y is deduced where "x" is the actual image size and "y" is the reticle scale reading in millimeters. The following fundus and corresponding en-face images of discs of the left eye of two patients depict the measurement of disc with the two methods [Fig. 4].

Results

A total of 127 eyes (65 right eyes and 62 left eyes) of 75 subjects, aged between 20 and 60 years were enrolled in the study. Among the 75 patients, there were 32 males and 43 females who were all of Indian origin. For each eye, the measurement of disc diameter was recorded manually with an OCT and reticle as mentioned before. The calculated mean diameter with OCT was 1.639 mm (standard deviation = 0.179) and that with reticle was 1.713 mm (standard deviation = 0.175), and

the difference in mean was 0.089 mm [Table 1] and standard deviations were homogeneous.

Based on the findings obtained, a figure [Fig. 5] was prepared, in which two graphs were overlaid. In one graph, OCT values against the difference between OCT and reticle values were plotted and in the latter, reticle values against difference in OCT and reticle values were placed. It could be observed from Fig. 3 that majority of the OCT and reticle values (majority of dots) lie within the difference of ±0.200 mm. It was found that the disc diameter could be assessed using reticle method with less than 0.15 mm difference (compared to OCT) in 83% of the eyes and 0.1 mm difference in 65% of the eyes. The mean values for both the methods were almost similar (lines on both the graphs move closely) in the majority of patients. A few extreme values make the lines in the graph wider toward the end (after a difference of 0.2 mm).

We conducted Kolmogorov Smirnov one sample test on the difference in the measures observed from both the methods and obtained a nonsignificant result (Z = 0.665, *P* value = 0.768). Linear regression analysis was performed with dependent variable (difference in reticle and OCT values) against independent variable (average of the OCT and reticle measures) and the nonsignificant results (t-value = 0.453, *P* value = 0.651) justified the agreement between these methods. Using Bland and Altman graph [Fig. 6], the data was plotted. We could not observe any trend in the data.

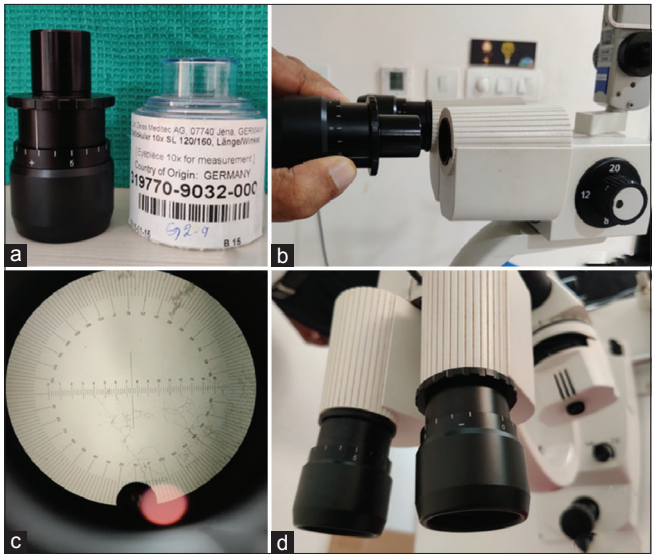

Figure 2: (a) Reticle incorporated eyepiece. (b) Inserting reticle after removing the right eyepiece. (c) View through reticle incorporated eyepiece (d) Reticle mounted onto slit lamp

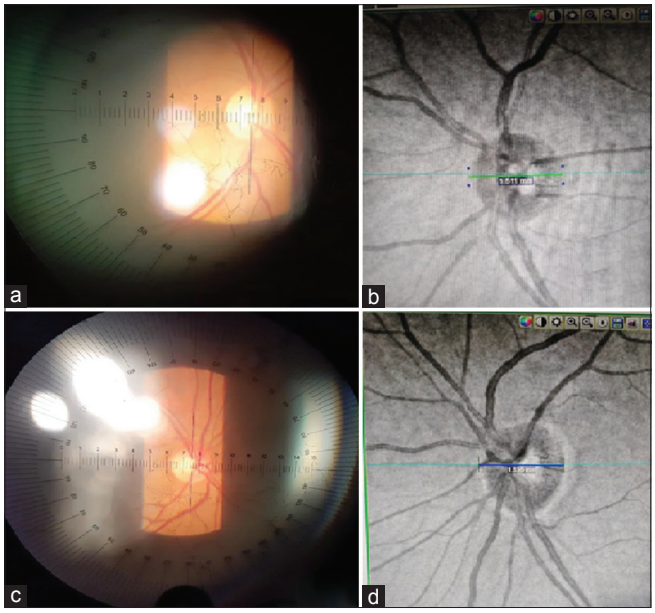

Figure 4: Reticle reading compared with OCT en-face reading of the same eye in two patients, where a minimal difference of 0.09 mm (a and b) and 0.11 mm (c and d) are noted between the two methods

Discussion

This research was conducted to find an easy and simple method to quantify the retinal lesions in normal clinical settings without using any sophisticated expensive instruments. These measurements were compared with OCT to know the reliability and accuracy of this method. Here, the optic disc diameter was taken as a landmark. The disc diameter was assessed using an OCT as the standard against which values obtained with a reticle and fundus contact lens were compared. 127 eyes from 75 individuals were evaluated with OCT and reticle methods. As seen in Table 1, the mean reticle value (1.713 mm) is more or less similar to OCT value (1.639 mm).

Measurements in the posterior segment are of great importance especially in the case of disc size in glaucoma or

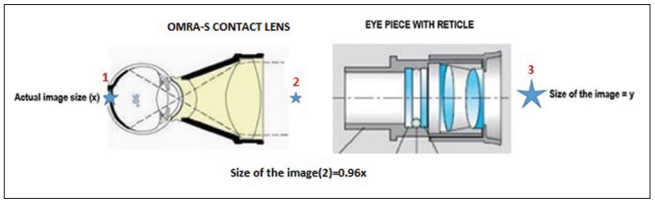

Figure 3: Schematic diagram showing image formation with a reticle and fundus contact lens. Here, 1 denotes "x" actual size of the image, observed through contact lens. 2 denotes the image of the object, that falls in front of the contact lens. 3 denotes "y" denotes final image that falls at observers end

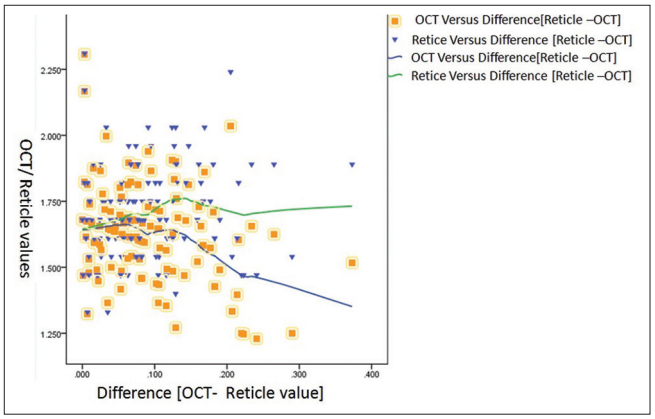

Figure 5: OCT and reticle values were plotted according to difference in OCT and reticle measures

Table 1: Descriptive statistics for optic disc assessed using OCT and Reticle methods and their differences

	n	Minimum (mm)	Maximum (mm)	Mean	SD*
OCT	127	1.229	2.307	1.639	0.179
Reticle	127	1.330	2.310	1.713	0.175
Difference	127	0	0.373	0.089	0.069

*Standard deviation

any retinal lesions which require regular monitoring of sizes such as choroidal nevus and choroidal melanoma.[10] These measurements become difficult in the absence of sophisticated and expensive machines such as OCT, SLP, or CSLO.

Various simpler methods have been described to measure the disc size such as slit-lamp biomicroscopy with condensing lens, planimetry, direct ophthalmoscope with Morgan's reticle or an illuminated cone. A simple and quick method is to use a condensing lens (60D, 78D, or 90D) on a slit-lamp and directly measure the size after applying the given correction factor.[5] Optic nerve head (ONH) measurement can also be done using the condensing lenses and comparing the size of the disc to the central retinal vein diameter.[6] Planimetry provides quantitative optic disk measurements by plotting disk stereo photographs on paper and measuring them manually or with the help of computerized techniques.[11] Instead of going into a more laborious planimetric measurement of disc, a comparable result can be obtained with a Welch Allyn hand-held ophthalmoscope with a 5-degree illuminated cone.[12] A reticle had been used by Morgan, earlier to measure posterior fundus landmarks by incorporating this into the optical system of an ophthalmoscope.[3]

All the above tests can have subjective variations and are time-consuming when compared to modern machines.[11] Also, it has been accepted that measuring retinal structures from photographs can be inaccurate.[13] Moreover, it has been shown that ONH size can vary with the measuring technique used.[12] Planimetric disc size measurements were found to be larger in comparison with other methods.[14,15] Recent evidence indicates that OCT scan artifacts and poor-image quality invariably challenges the interpretation of test results.[8] Discrepancies in measured values were seen even with sophisticated measuring modalities in certain cases like minimal tilted discs.[16] Moghimi *et al*. in his two studies found that CSLO overestimated optic disc area as compared to SD-OCT.[17,18] According to Ramakrishnan *et al*., OCT analysis of the optic disc produces significantly smaller parameters, compared to the established method of optic disc planimetry.[19] ONH parameters measured with OCT yielded a slightly better diagnostic performance than CSLO in Calvo *et al*.'s study.[20] The agreement between stereo biomicroscopy and HRT disc diameter measurements is moderate and disc diameter measurement on stereo biomicroscopy can be used to categorize discs into small, average, and large discs (Rao *et al*.).[21] Methods adopted in this study can also be used for this categorization.

Although condensing lenses can give a reasonably accurate measurement of discs, mild variation in readings is seen depending on the dioptric power of the lens used. The one with the lowest power, which gave the larger image magnification,

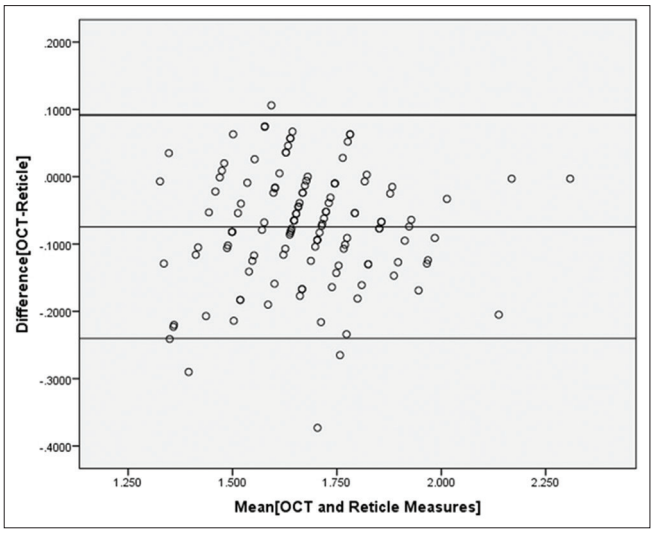

Figure 6: Bland and Altman graph

correlated well with the disc size.[6] High-magnification minimizes the depth of the field and should reduce errors in the measurement.[11] The Ocular Mainster focal/grid laser lens used here provides both high lateral magnification that offers excellent retinal detail and axial magnification that permits appreciation of subtle intraretinal details and retinal thickening. Retinal resolution is high with this lens and visibility through hazy media is excellent. Magnification of this lens is higher than most of the contact lenses and condensing lenses that are used in evaluating the fundus.[22]

A fundus contact lens is preferred to a condensing lens, as a contact lens removes corneal reflexes, neutralizes the irregularities of cornea and prevents even a slight movement of examining eye which can affect the size of the image seen.[23] As the contact diameter of this lens is 15.5 mm, induced corneal folds hardly occur.

Repeatability and reproducibility of the Zeiss 4 mirror contact lens are comparable to other methods.[24] This lens, as well as a 78 D condensing lens, showed good correlation in measuring ONH with the computerized images of the disc.[25] The correlation and agreement were much stronger for a Zeiss 4 mirror lens than for a condensing lens.[26] Unlike a 4-mirror Zeiss contact lens, the image size of the object was larger, with the contact lens used in the present study, thus giving a more accurate measurement of the disc. Also, the contact diameter of the lens in this study had a contact diameter of 15 mm as compared to the Zeiss lens with 9 mm diameter, which minimizes corneal distortion totally. In another comparative study, the 78 D condensing lens, which is commonly employed in assessing the disc size, gave unsatisfactory results when compared with planimetry.[27]

The efficacy of this study includes the prevention of subjective variations as all readings were taken by a single examiner and dilated examination was done in all patients. All measurements were taken by the observer through the slit-lamp in real time. However, it was observed that measurement of the disc by photograph-assisted reticle method, further improved accuracy.

Conclusion

The deliberations and examinations were undertaken in this study to conclude that retinal measurements with a simple and comparatively inexpensive technique using fundus contact lens and reticle are comparable with OCT measurements. This method can be employed in measuring posterior fundus lesions where expensive and sophisticated machines are unavailable.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Walling PE, Dinardo A. The Lost Arts of Optometry, Part Two. Put the 'Fun' Back in fundoscopy. Review of optometry. Sep15; 2013:58.
2. Alfred C. Perimetric chart for measuring retinal lesions. AJO 1921;4:28-31.
3. Morgan OG. A retinal graticule. Br J Ophthalmol 1927;11:339-41.
4. Dacosta S, Bilal S, Rajendran B, Janakiraman P. Optic disc topography of normal Indian eyes: An assessment using OCT. Ind J Ophth 2008;56:99-102.
5. Snead MP, Rubinstein MP, Jacobs PM. The optics of fundus examination. Surv Ophthalmol 1992;36:439-45.
6. Lim CS, O'Brien C, Bolton NM. A simple clinical method to measure the optic disc size in glaucoma. J Glaucoma 1996;5:241-5.
7. Greenfield DS, Weinreb RN. Role of optic nerve imaging in glaucoma clinical practice and clinical trials. Am J Ophthalmol 2008;145:598-603.
8. Paunescu LA, Schuman JS, Price LL, Stark PC, Beaton S, Ishikawa H, *et al*. Reproducibility of nerve fiber thickness, macular thickness, and optic nerve head measurements using Stratus OCT. Investigative Ophthalmology & Visual Science 2004;45:1716-24.
9. Hardin JS, Taibbi G, Nelson SC, Chao D, Vizzeri G. Factors affecting Cirrus-HD OCT optic disc scan quality: A review with case examples. J Ophthalmol 2015;2015;746150.
10. Saurabh K, Roy R, Sinharoy S, Shah D, Nangia P. Measurement of size of pigmented choroidal nevus: Superiority of multicolor imaging compared to conventional color fundus photography. Indian J Ophthalmol 2018;66:1501-3.
11. Hoffmann EM, Zangwill LM, Crowston JG, Weinreb RN. Optic disk size and glaucoma. Surv Ophthalmol 2007;52:32-49.
12. Gross PG, Drance SM. Comparison of a simple ophthalmoscopic and planimetric measurement of glaucomatous neuroretinal rim areas. J Glaucoma 1995;4:314-6.
13. Arnold JV, Gates JW, Taylor KM. Possible errors in the measurement of retinal lesions. IOVS 1993;34:2576-80.
14. Jonas JB, Mardin CY, Gründler AE. Comparison of measurements of neuroretinal rim area between confocal laser scanning tomography and planimetry of photographs. Br J Ophthalmol 1998;82:362-6.
15. Jonas JB, Papastathopoulos K. Ophthalmoscopic measurement of the optic disc. Ophthalmology 1995;102:1102-6.
16. Hoffmann EM, Bowd C, Medeiros FA, Boden C, Grus FH, Bourne RR, *et al*. Agreement among three optical imaging methods for the assessment of optic disc. Ophthalmology 2005;112:2149-56.
17. Moghimi S, Mahdavi KN, Rahardjanoto L, Lee G, Bitrian E, Riddle J, *et al*. Spectral-domain OCT underestimates disc and rim areas compared to confocal laser ophthalmoscopy. Invest Ophthalmol Vis Sci 2011;52:3062.
18. Moghimi S, Hosseini H, Riddle J, Lee GY, Bitrian E, Giaconi J, *et al*. Measurement of optic disc size and rim area with spectral-domain OCT and scanning laser ophthalmoscopy. Invest Ophthalmol Vis Sci 2012;53:4519-30.
19. Ramakrishnan R, Kader MA, Budde WM. Optic disc morphometry with optical coherence tomography: Comparison with planimetry of fundus photographs and influence of parapapillary atrophy and pigmentary conus. Indian J Ophthalmol 2005;53:187-91.
20. Calvo P, Ferreras A, Abadia B, Ara M, Figus M, Pablo LE, *et al*. Assessment of the optic disc morphology using spectral-domain optical coherence tomography and scanning laser ophthalmoscopy. Biomed Res Int 2014;2014:275654.
21. Rao HB, Sekhar GC, Babu GJ, Parikh RS. Clinical measurement and categorization of optic disc in glaucoma patients. Indian J Ophthalmol 2009;57:361-4.
22. Mainster MA, Reichel E, Harrington PG, Erickson PJ, Graham RD. Ophthalmoscopic contact lenses for transpupillary thermotherapy. Semin Ophthalmol 2001;16:60-5.
23. Walling PE, Pole J, Karpecki P, Colatrella N, Varanelli J.Condensing Lenses: Sharpen Your Skills in Choosing and Using. Rev Optometry 2017:58.
24. Spencer AF, Vernon SA. Optic disc measurement with the Zeiss four mirror contact lens. Br J Ophthalmol 1994;78:775-80.
25. Akman A, Oram O, Aydin P. Optic disc measurements with the 78 diopter lens, zeiss 4-mirror contact lens and computerized image analyzing system. Eur J Ophthalmol 1998;8:22-7.
26. Spencer AF, Vernon SA. Optic disc height measurement with the Zeiss 4-mirror contact lens and 78 dioptre lens compared. Eye 1996;10:371-6.
27. Spencer AF, Vernon SA. Optic disc measurement: A comparison of indirect ophthalmoscopic methods. Br J Ophthalmol 1995;79:910-5.