Original Article

Comparison of standard and "innovative wide-field" optical coherence tomography images in assessment of vitreoretinal interface in proliferative diabetic retinopathy: A pilot study

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Purpose: To compare the standard and "innovative wide-field" optical coherence tomography images in assessment of vitreoretinal interface in proliferative diabetic retinopathy. **Methods:** Fifty consecutive eyes of 25 patients with proliferative diabetic retinopathy underwent 12 × 12 mm radial swept source-optical coherence tomography (OCT) imaging using standard technique and innovative wide-field (+90D) technique. The image expansion ratio was calculated using Image J software. **Results:** Out of the 50 eyes, only in four eyes with +90 D were minimally misaligned or were having quality less than grade 2 as compared to standard OCT. The mean age group was 51 ± 4.5 years. The expansion ratio (scan length) increased by a factor of 1.65 ± 0.67 when obtained using +90 D technique. **Conclusion:** Innovative wide-field technique provides us with the widest of available OCT scans with the presently available machine and the software.

Key words: Optical coherence tomography, proliferative diabetic retinopathy, vitreoretinal interface, wide-field optical coherence tomography

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Since its invention, optical coherence tomography (OCT) has made remarkable advancements in both image resolution and acquisition speed. Recent improvements to commercially available OCT systems have also included increasing scan length. The DRI OCT Triton plus (Topcon, Tokyo, Japan), a commercially available, swept-source OCT system, is capable of producing a 12-mm radial scan. The quest for imaging a wider field with the same fixation point made us ponder on how to visualize further beyond with the presently available 12/12 mm scans currently available in the OCT machines. A simple technique to expand the scan length on OCT has been reported as an extended field imaging (EFI) technique, which involves imaging the posterior pole through trial frames fitted with a +20 diopter lens.[1,2] We went a step ahead and utilized a similar principle by employing a higher power +90 diopter double aspheric noncontact slit-lamp lens as an "innovative wide-field" optical coherence tomography imaging technique.

Preoperative OCT assessment of vitreoretinal interface abnormalities in patients with proliferative diabetic retinopathy (PDR) can assist in decision making, in terms of identifying accurate plane of dissection, or in avoiding elevated neovascular fronds when performing pan retinal photocoagulation. In this study, we sought to further explore the feasibility of the technique in identifying the wider perspective of vitreoretinal interface abnormalities in eyes with PDR as compared to the conventional presently available 12/12 radial OCT scan.

Methods

This study was a prospective study of fifty eyes of 25 patients with PDR who visited our eye hospital between January 2017 and May 2017. This study was approved by the Institutional Review Board and was conducted in accordance with the ethical standards stated in the 1964 Declaration of Helsinki. The inclusion criteria were any subject having proliferative diabetic retinopathy requiring OCT scan, with clear media and good fixation (BCVA 6/12 or better). The eyes with poor quality images due to media opacities or poor fixation were excluded from the study. Optical coherence tomography images were captured using Topcon Swept Source DRI OCT Triton Plus™. A set of 12 mm radial OCT scans centered on fovea were captured in all subjects with standard technique and +90D as elaborated below. Multiple attempts were made to get the best quality scan.

The technique involved:-Step 1–Performing a fovea centered standard 12 mm radial protocol OCT scan. Step 2–Performing a fovea centered OCT scanning 12/12mm radial protocol with a +90 D double aspheric noncontact slit-lamp biomicroscopy

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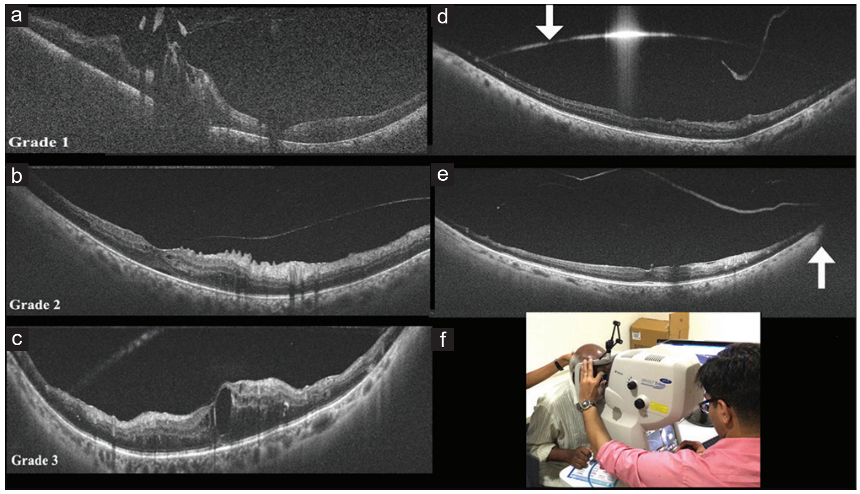

Figure 1: The image quality was analysed by assessing the visibility of ellipsoid zone. (A-C)The image quality graded on a scale of 1 to 3 with 1 being the poor quality and 3 being the best showed in the image. Artefacts as shown in the image D - Lens reflections marked with downward white arrow, E - Lens edge effect marked with upward white arrow. F Innovative wide-field imaging technique - +90.00 diopter double aspheric lens, stabilised in examiners hand, held in-between the objective lens of the OCT & patient eye, keeping the lens as close to the eye as possible.

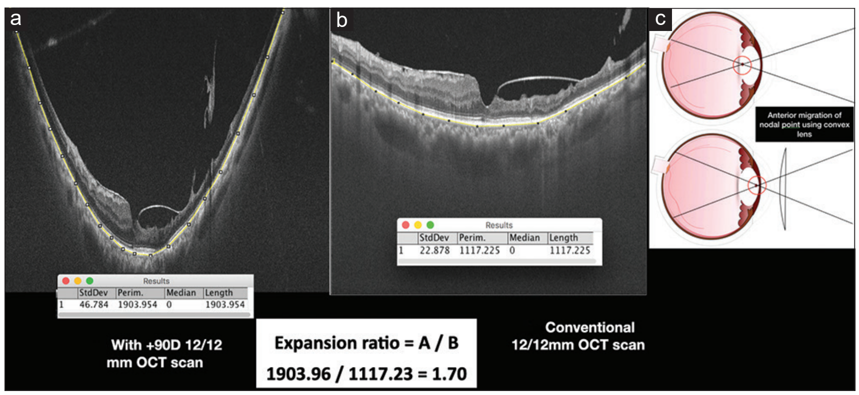

Figure 2: Image showing the calculation of expansion ratio, (a) Measurement of the scan length of the conventional 12/12 mm OCT with +90D lens using Image J. (b) Measurement of the scan length of the conventional 12/12 mm OCT using Image J. (c) A convex lens placed between the eye and the OCT machine increases the imaging light incidence angle resulting in imaging field expansion

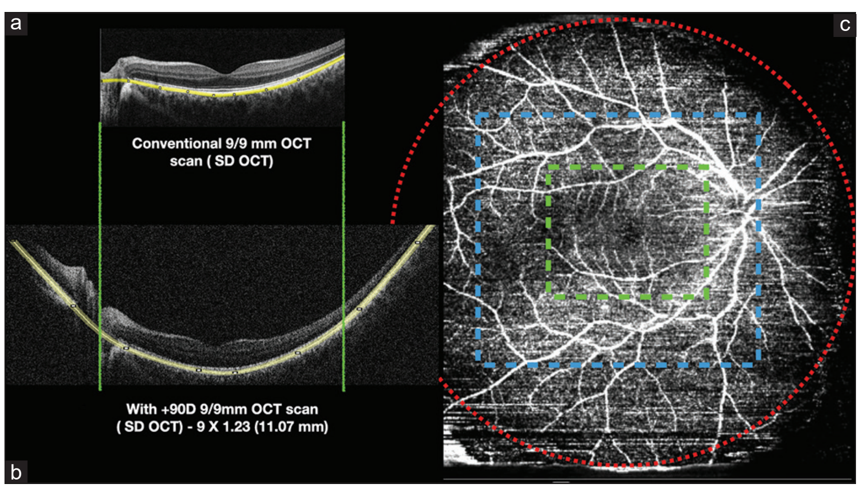

Figure 3: Image showing (a) A 9/9 mm conventional radial scan in a spectral domain OCT, (b) comparative image of the enlarged scan length with innovative wide field OCT (+90D lens) scan. (c) Showing OCT Angiography (OCTA) image with 12/12 mm scan protocol with innovative wide field OCT technique (+90 D) showing a widest field OCTA approximate 20 mm (12X 1.7 = 20.4 mm) depicted in red dotted circle, comparative green hashed rectangle is depicting the area of the scan using 9/9 mm scan protocol and blue hashed rectangle is depicting the area of the scan using 12/12 mm scan protocol

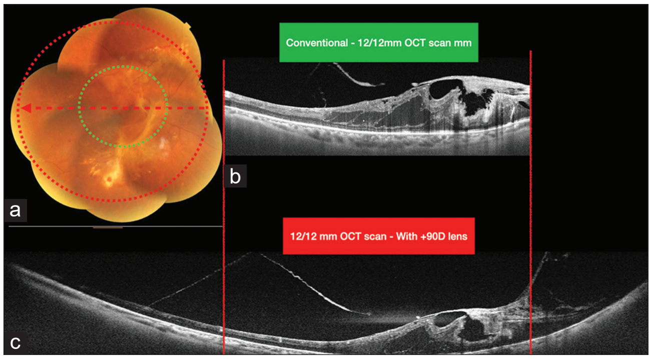

Figure 4: Image showing (a) Corresponding fundus image, green circle (12/12 mm scan), red circle innovative wide field OCT with +90 D lens, red arrow showing the representative site through which the b scan is passing, (b) Conventional 12/12 mm OCT scan showing the dense attachment of membrane over the disc, (c) Innovative wide field OCT with +90 (d) wider scan length with better visualisation of the dissection plane nasal & temporal to the disc with secondary membranes visualised on the nasal side

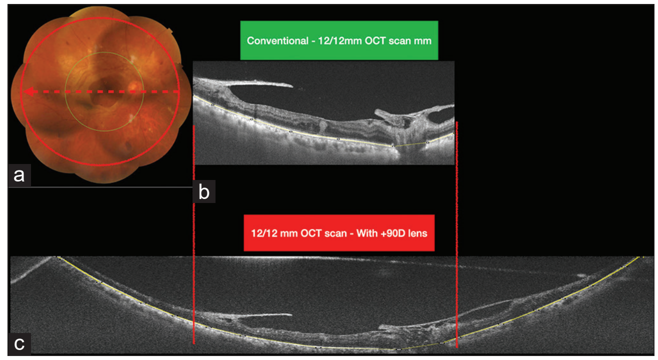

Figure 5: Image showing (a) Corresponding fundus image, green circle (12/12 mm scan), red circle innovative wide field OCT with +90 D lens, red arrow showing the representative site through which the b scan is passing, (b) Conventional 12/12 mm OCT scan showing the attachment of membrane over the disc, (c) Innovative wide field OCT with +90 (d) wider scan length with better visualisation of the incomplete posterior vitreous detachment with focal points of attachments noted beyond the posterior pole

lens, stabilized in examiners hand, held in-between the objective lens of the OCT and patient eye, keeping the lens as close to the eye as possible. Using the joystick the OCT machine is taken as close to the +90D lens which is placed close to the eye until an infrared image of the iris is seen on the infrared live image and then the manual focusing of the OCT is done by manually rotating the knob in the OCT machine to negative sign (high minus lens) and manually focusing the OCT using the Z-axis and fine tuning focus with the manual focusing knob [Fig. 1f].

The image quality was analyzed by examiner (DM) assessing the visibility of ellipsoid zone. The image quality was graded on a scale of 1 to 3 with 1 being the poor quality and 3 being the best. [Fig. 1a-c]. The expansion ratio was calculated using Image J software (NIH) (http://imagej.nih.gov/ij/) by examiner (DM). The expansion ratio calculation was done with measuring the scan length at the level of RPE layer in the B scan image of the OCT using Image J software. The B scan image of the conventional OCT was opened in the Image J software and the pixel length was measured along the circumference of the OCT and the same was done of the +90D image. The expansion ratio for +90D image was calculated by dividing the respective values noted by the value noted in the conventional OCT image [Fig. 2a and b].

Results

A total of 50 eyes of 25 patients with PDR were included in the study of which 15 were male and 10 were female. The mean age group was 51 ± 4.5 years. The image quality assessment revealed that 96 ± 2.4% were of grade 3 in the standard OCT images and 89 ± 3.3% were of grade 3 in OCT images with +90 D lens. No artefacts were seen in standard OCT. Rim artefacts in OCT images were seen in 6 ± 1.3% eyes with +90D OCT images [Fig. 1d]. Edge artefacts in OCT images were seen in 7 ± 3.6% eyes with +90D OCT images [Fig. 1e]. The expansion ratio (scan length) increased by a factor of 1.65 ± 0.67 when obtained using +90 D technique [Fig. 2a and b]. Out of the 50 eyes, only four eyes with +90 D were minimally misaligned as compared to standard OCT.

Discussion

A convex lens placed between the eye and the OCT machine theoretically increases the imaging light incidence angle resulting in imaging field expansion [Fig. 2c]. The convex lens causes least angular minification of the target, which also increases the field of OCT. Since the eye is a globular structure, the concavity of posterior pole also contributes to increase in the scan length.

The same technique can be utilized to enhance the performance of the even the older spectral domain OCT (we have tried on 3D OCT-1 Maestro, Topcon, Tokyo, Japan) which can give you the wider scan length with the approximate magnification factor of 1.23 with +90D (9mm scan can give us approximately 11.07 mm of the scan length) [Fig. 3a and b].

Furthermore, this innovative wide-field optical coherence tomography imaging results in a minimal decrease in image resolution because it does not change the hardware capabilities of the OCT system; it would be better if we have a better and denser scan volume available in the next generation OCT system. It simply magnifies each pixel, so in certain cases, detailed information is missed, but there is no gross loss of details of the retinal architecture. In the peripheral fundus in general, the need for very high resolution is less than in the macular area. Hence, the slight compromise in reduced resolution is acceptable while giving us a panoramic OCT view of a large segment of fundus at one time that defines the vitreoretinal relationship well. The pupil size is not the limiting factor in the quality of the scan unless there is a media opacity hampering a good quality scan. Wider the pupil, better is the scan quality of the peripheral OCT.

Reflection and rim artefacts are common with the EFI technique.[1] The lens used in 'innovative wide field' OCT imaging, has better anti-reflective coating and double asphericity. So reflection artefacts are negligible and do not hamper the visualization of details in majority of the cases. Assessment of vitreoretinal interface plays an important role in diabetic vitrectomy. The "innovative wide-field" OCT imaging technique helps in the identification of surgical plane or extent of the secondary membrane beyond the posterior pole; this can help in better identifying the site of safe initiation of the membrane dissection and can improvise our surgical outcome [Figs. 4 and 5]. The 'innovative wide-field' OCT imaging technique also enables us to identify the areas of raised neovasculrization elsewhere (NVE) beyond the posterior pole. Hence, these areas can be identified and avoided while performing pan laser photocoagulation. We have utilized our technique of utilizing +90.00 Diopter double aspheric noncontact lens and performing the 12/12 mm OCT angiography scan protocol to give us a widest field OCT angiography (OCTA) approximate 20.4 mm as compared to 16.7 mm in the study mentioned by author Kakihara *et al*.[3] [Fig. 3c]. It appears that there is not much degradation of image for OCT vs. OCTA. The degradation of the radial scan depends upon the media clarity, patient fixation, and the clarity of the lens (90D).

Further innovative wide-field optical coherence tomography imaging technique can also be tried in acquiring scans for mid-peripheral lesions. The other modes of low-cost imaging which includes montage imaging as described by Ranjith *et al*. and Han *et al*. can be utilized for wide-field OCT imaging.[4,5] The limitations of our present study includes minimal learning curve and the fact that this was a study that only included a small limited number of patients. The biggest disadvantage of the above-mentioned technique is that the color photo of fundus cannot be acquired as the flash gets reflected from the anterior surface of the lens. If the machine were capable of obtaining pseudocolor images as in Heidelberg SPECTRALIS®, it may be possible to obtain better wider field fundus images as well.

Conclusion

In summary "innovative wide-field" optical coherence tomography imaging technique utilizing +90 Diopter double aspheric noncontact slit-lamp lens can be used effectively in acquiring the wider length of OCT scan with the presently available machine and the software. It can help in various cases scenarios of vitreoretinal interface disorders and identification of correct cleavage plane in vitrectomy. It can provide us the widest OCTA image without any change in the presently available technology.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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