Commentary: Utility of a smartphone-assisted direct ophthalmoscope camera for a general practitioner in screening of diabetic retinopathy at a primary health care center

With over 77 of the 463 million people suffering from diabetes mellitus (DM) globally residing India, it is not surprising that our country is dubbed as the diabetic capital of the world.[1] DM is associated with microvascular and macrovascular complications, with diabetic retinopathy (DR) being the most common microvascular complication. Screening for DR, especially sight-threatening diabetic retinopathy (STDR), is of paramount importance in order to prevent permanent visual impairment. Although stereoscopic color fundus photography and fundus fluorescein angiography are the gold standards for diagnosis of DR, they are not suitable as screening tools. These tests require expensive fundus cameras that are bulky, generally are not portable and are operator dependent. Smartphone-based imaging (SBI) has emerged as a useful screening tool for DR owing to its ready availability and cost effectiveness, especially in resource-limited settings.[1,2] SBI has evolved from use of a 20 diopter (D) condensing lens to use of various attachments and adaptor that allow clinicians to capture good quality retinal images. Studies have shown smartphone-based grading to be at par with slit-lamp biomicroscopic grading of DR. These newer

imaging devices claim to have a specificity and sensitivity of more than 90% in detecting DR. This allows paramedics and technicians to perform community based screening, transfer the images to a trained ophthalmologist, thereby allowing timely referral of patients requiring treatment.[2] The authors have published a manuscript highlighting the utility of a monocular direct ophthalmoscope SBI device to detect DR and diabetic macular edema in this edition of Indian Journal of Ophthalmology.[3]

SBI systems can be broadly classified into mydriatic (M) or nonmydriatic (NM) types.[2] Some of the M SBI systems include:

1. Sharma *et al*.[4] have shown the effective use of smartphone-based MII Ret Cam, allowing fundus photography of the posterior pole as well as the peripheral retina. Raju *et al*.[5] have developed a DIY retCAM, which can be self-assembled and attached to a smartphone. Apart from color fundus imaging, it offers the added advantage of fundus fluorescein angiography by using matched filters. Volk iNview and Vistaview are some of the other available M SBI devices that allow a wide field view of the fundus.[2]
2. NM SBI has evolved in the recent past with development of clip-on adaptors, which allow retinal imaging without the need for pupillary dilatation or condensing lenses. Some of the commercially available devices are D-EYE, Peek Retina, and iExaminer, of which D-EYE and iEXAMINER are FDA approved.[2,6,7] D-EYE has a light-emitting diode and a working distance of 1 cm with capabilities to autofocus between -10 D and +5 D. Peek Retina uses a prism to deflect the light from the camera flash and allows autofocusing of the retinal image. A major drawback of these clip-on SBI devices is the limited field of view (FOV).[2,7] Cellscope Retina is another handheld SBI application, which allows one to capture high-quality wide field images of the retina and make a five-image montage with roughly 100° FOV. Fundus on phone (FOP) is another FDA-approved device, available in both M and NM modules. The FOP-M device has a FOV of 45° with 12× magnification, while the FOP-NM device has a FOV of 40° with 10× magnification. Advantages of this system include automated image montaging, artificial intelligence (AI) analysis for automated DR screening and an inbuilt application for image storage and retrieval. Studies have shown high sensitivity and specificity rates with this device for detecting STDR.[7,8]

The advent of AI and machine-based learning and its integration into smartphones is likely to further ease the process of screening for STDR. AlexNet, Medios, and EyeArt are the currently available AI platforms for retinal imaging. Studies have shown high sensitivity and specificity to detect referable DR, with both M and NM systems, using AI-based algorithms.[2,7]

To conclude, smartphone-based fundus imaging has emerged as a helpful tool in screening patients with STDR, especially in remote areas and low-income regions of the world. Consistently reproducible results, ease of use, portability, low cost, cloud storage, and AI integration have enhanced the capabilities of smartphone-based fundus imaging as a powerful weapon in the fight against diabetic eye disease.

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Access this article online

Quick Response Code:

Website: www.ijo.in

DOI: 10.4103/ijo.IJO_2387_21

Cite this article as: Markan A, Singh SR, Dogra M. Commentary: Utility of a smartphone-assisted direct ophthalmoscope camera for a general practitioner in screening of diabetic retinopathy at a primary health care center. Indian J Ophthalmol 2021;69:3148-9.