Regarding fundus imaging with a mobile phone: A review of techniques

Dear Sir,

We read with interest the article by Shanmugam *et al*.[1] while most articles in literature describe the technique using the iPhone™ (Apple Inc., Cupertino, USA), we would like to share our experience using Samsung S3 and Note 3 android mobile phones (Samsung Electronics Ltd., Suwon, South Korea) as fundus imaging devices. Compared to iPhone, android phones cost less, but have similar functionality.

One difficulty highlighted by the authors is that the flashlight not being continuously on while capturing the images in the still photography mode. Using the "assistive light widget," preloaded in most android phones, the flash can be kept on in still photography mode. This improves the quality of images as the still photography mode [Fig. 1] gives better resolution compared to a video image. Likewise, iPhone has newer camera Apps (Camera Plus by Global Delight Technologies, Udupi, India) with similar options like the assistive light.

Following modifications are suggested:

- Use a 28 diopter lens instead of the 20 diopter lens: A smaller, lighter lens with shorter focal length is easier to handle
- Zoom to the maximum and fill the entire screen with the fundus image to get a better focus of the retinal details
- Moving closer to the condensing lens improves the focus of the fundus image
- Use the "touch focus" option if available. With this feature, one can touch the screen over the area of interest focusing that area better. An android camera App similar to the one described by Haddock *et al*.,[2] is Camera FV-5 (http://www.camerafv5.com) and the user can control numerous functions of the camera with this App, improving the overall quality of the photograph
- Reducing the exposure to −1 or − 0.5 gives adequate exposure levels
- After the capture, crop the selected images and adjust the image quality using the Image Editing Software on the phone itself before it is transferred to the computer or shared wirelessly using Bluetooth, E-mail or using a cross-platform messaging software like WhatsApp (WhatsApp, Inc., Mountain View, CA, USA).

We have used the mobile phone to photograph the fundus changes in retinopathy of prematurity (ROP) [Fig. 2] and found it useful in documentation, educating parents, for follow-up and in tele-ophthalmological consultations.

We have documented peripheral retinal changes, which are not accessible with the standard fundus camera [Fig. 3a-c]. Excellent quality images could be obtained in postoperative cases as well [Fig. 3d]. It is also possible to take stereo images by slightly offsetting the 2 images [Fig. 4].

As mentioned by the authors, this technique is cost effective, especially in outreach centers where a dedicated fundus camera may not be available. This technique can play a significant role in tele-ophthalmology, especially in ROP as the available

Figure 1: Fundus imaging using android mobile phone: (a) Optic pit with resolved maculopathy. (b) Beaten bronze appearance in Stargardt's disease. Note the two reflexes from anterior and posterior surfaces of the condensing lens seen in images taken with this technique

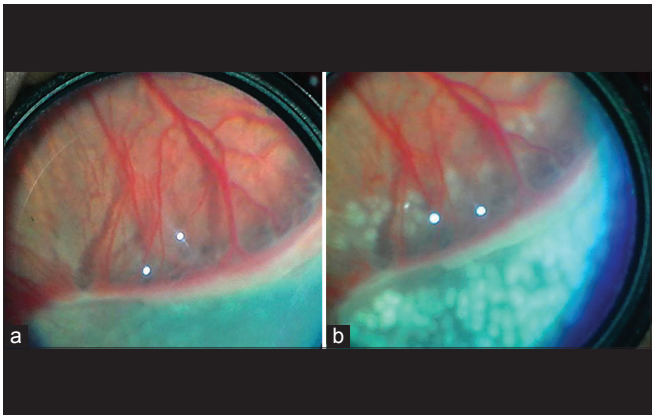

Figure 2: Documenting fundus changes in retinopathy of prematurity (ROP) using mobile phone indirect ophthalmoscopic technique: (a) Stage 3 with plus in zone II ROP. (b) Same eye, immediately after laser indirect photocoagulation

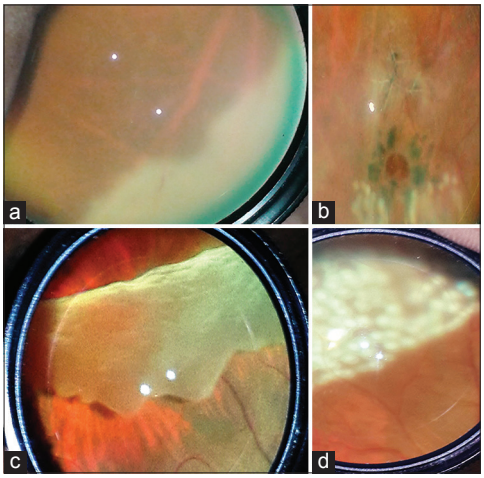

Figure 3: Documenting peripheral retinal changes using mobile phone indirect ophthalmoscopic technique: (a) Acute retinal necrosis. (b) Lattice and atrophic hole with surrounding laser barrage. (c) Superior giant retinal tear with inversion. (d) Same eye on 1st postoperative day

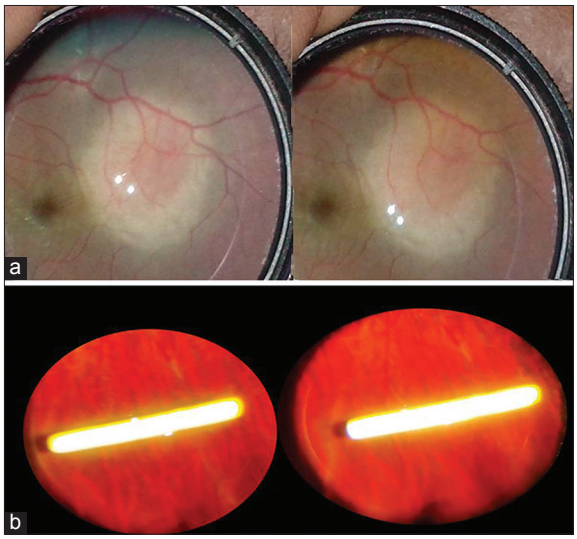

Figure 4: Stereo photographs using mobile phone indirect ophthalmoscopic technique: (a) Tubercular choroidal abscess. (b) Intravitreal dexamethasone implant (Ozurdex®, Allergan, Inc., Irvine, CA) in the inferior vitreous

methods for fundus documentation are beyond the reach for most practitioners.

Improvement in camera functions and innovations like an attachment of the miniature fundus camera optical system[3] to the mobile phone are exciting developments in the offing, which will make this technique more acceptable.

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