Capturing fundus Image with smartphone indirect ophthalmoscopy: a newer technique

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Smart phones, with their ever increasing popularity, and the rapid advances in technology have made their way into Ophthalmology as imaging devices for both anterior and posterior segment. Smartphone anterior segment photography using various slit lamp adapters has become quite popular as compared to the traditional inbuilt slit lamp cameras. In contrast, the use of smart phone along with a condensing lens to capture images of the posterior segment has not quite been able to replace the commercially available fundus cameras, due to its long learning curve and poor quality of images.

In this article we explain how the basic technique of smart phone indirect ophthalmoscopy can be evolved further so as to capture high quality fundus images.

Materials and Methods:

The basic materials needed are a smart phone and a condensing lens (20D, 28D). Principle of working: The LED light of the phone acts as a coaxial light source to illuminate the patient's retina, and is turned 'ON' throughout the procedure. This system works as an indirect ophthalmoscope wherein the camera creates a digital image of the fundus on the phone screen through the condensing lens (Fig 1)[1,2,3] .

Fig 1: Principle of working

The original method of smart phone indirect ophthalmoscopy where the phone and condensing lens are held by hand is a difficult technique to master and does not yield very high quality images of the fundus. This is due to the fact that the camera and lens are quite unstable when being held manually, and fine focussing is not possible with it. Hence, the distance between the phone and the lens needed to be made constant, so as to make the system more stable. The blog titled 'DIY RETCAM' by Dr Biju Raju showed that by using cheap and readily available materials like a phone back cover, PVC pipes, black cloth.etc, a simple adapter could be made onto which the phone and condensing lens could be fitted at an appropriate distance[4] .

With this new instrument, we were able to obtain decent quality fundus images, as the instrument could be held with one hand and the phone was at a fixed distance from the condensing lens. However it still proved to be cumbersome and technically difficult to perform as the instrument was bulky and heavy to hold. In order to improve the stability and comfort, we evolved it further by using additional PVC pipes and connectors, so that it could now be mounted on any slit lamp via the universal adapter hole (Fig 2). Ethical clearance was obtained from the institutional ethics committee.

Fig 2: (A)Our instrument, (B)Instrument after mounting on slit lamp

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Details of the procedure are as follows[5]: good pupillary dilatation, LED flashlight remains "on" throughout the procedure, camera in video record mode and manual focus, saving and editing of images using any Android/iOS based software.

Results:

With the slit lamp mounted device, we were able to obtain good quality fundus images. Since the instrument is attached to the slit lamp, it was not needed to be hand held, and the hands could be used to control the joystick for allowing finer adjustments. Moreover, both the patient and the doctor can be seated comfortably during the procedure.

The only drawback that we noticed was a central reflection artefact that was seen due to the reflections from the lens surface. However, we could eliminate it using Android/iOS based software (Adobe Photoshop Express) on the phone itself (Fig 3). Also, by using cross polarization with simple polaroid filters, we could eliminate the central reflection. However, using polarized filters significantly decreased the intensity of the LED light which reduced visualization of some of the minor details, especially in old patients with cataracts.

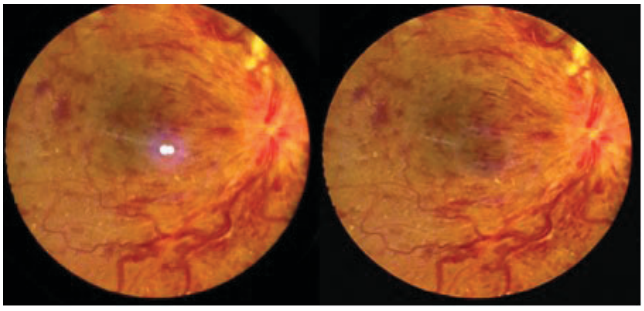

Fig 3: CRVO, Left – with central reflection, Right – after eliminating central reflection

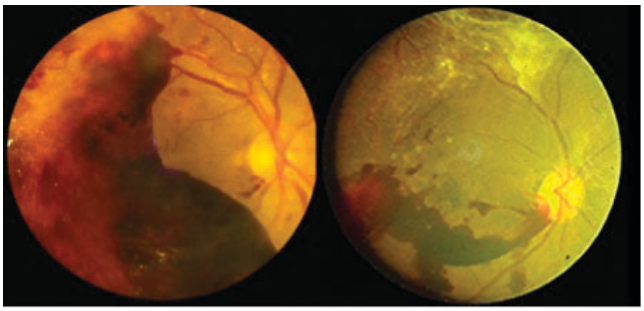

Fig 4: Subhyaloid hemorrhage

With the 20D condensing lens, we were able to obtain about 30 degrees of field of view of the posterior pole (Fig 4). For viewing retina periphery beyond equator, we detached the instrument from the slit lamp and used the hand held method (Fig 5).By taking 2 similar images from slightly different angles; we were also able to obtain stereo fundus photographs for depth perception (Fig 6).

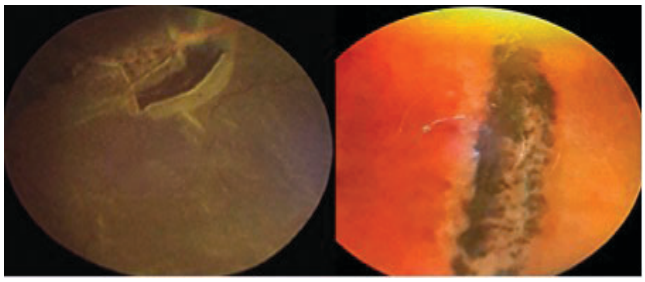

Fig 5: Retina periphery: Left – Horseshoe tear, Right – Lattice degeneration

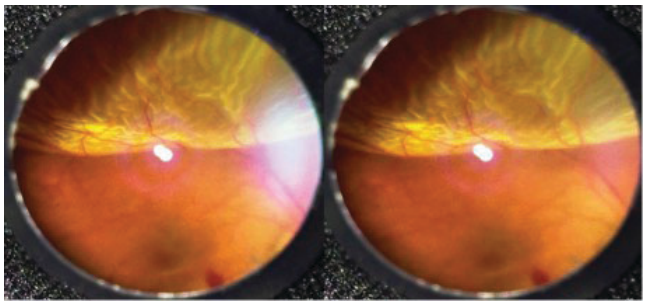

Fig 6: Bullous retinal detachment, stereo images

Discussion:

With the smart phone fundus camera adapter, we obtained workable quality images of the posterior pole and retina periphery, including stereo photographs. It is simple to operate once mounted on the slit lamp, and can easily be performed. It may also serve as a good teaching tool for students to demonstrate various ocular fundus pathologies. The total cost of making this smart phone adapter including that of PVC pipes, black sand paper, sticking glue, double tape, metal stand and phone back cover does not amount to more than INR800. Thus, the adapter proves to be a workable solution in a setting where a fundus camera is not available. Being light and portable, the instrument can be easily carried from one place to another and can be mounted on all types of slit lamps. It can also be used in peripheral centres where slit lamps are not available.

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