SMARTPHONE INDIRECT OPHTHALMOSCOPY: FOR SCREENING, EVALUATION AND DOCUMENTATION OF THE OCULAR FUNDUS

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ABSTRACT

Smartphones, 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.

KEYWORDS: Smartphones, Imaging Devices, Lamp Cameras

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INTRODUCTION

In contrast, the use of smartphones 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 (Figure 1).

Figure 1: Left – Method of Smartphone Indirect Ophthalmoscopy, Right – Quality of Fundus Images

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

MATERIALS AND METHODS

The basic materials needed are a smartphone 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 (Figure 2).

Figure 2: Principle of Working

The original method of smartphone indirect ophthalmoscopy where the phone and condensing lens are held by hand\textsuperscript{2,3,4,5}, 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 focusing 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\textsuperscript{1} (Figure 3).

Figure 3: Left – Materials Used, Right – Hand Held Smartphone Fundus Camera Adapter

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 4).

Figure 4: A: Universal Adapter Hole on Slit Lamp, B: Our instrument, C: Instrument after Mounting on Slit Lamp, Arrow: Part of Instrument that Fits into Adapter Hole of Slit Lamp

Details of the procedure are as follows:

- Good pupillary dilatation prior to procedure
- LED Flashlight: Remain “on” throughout the procedure
- Camera: Video record mode, Manual focus
- Saving, editing of images using any simple Android/iOS based software
- Sharing of images through social networking media

RESULTS

With the slit lamp mounted device, we were able to obtain excellent quality fundus images. Since the instrument is attached to the slit lamp, it does not need to be held at all, in fact the hands can 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 did not find this too much of an issue as we could eliminate it using a simple Android/iOS based software (Adobe Photoshop Express) on the phone itself (Figure 5). Also, by using cross polarization with simple Polaroid filters, we could eliminate the central reflection (Figure 6). 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.

![Figure 5: CRVO, Left – with Central Reflection, Right – after Eliminating Central Reflection](image)

![Figure 6: Normal Fundus, Photo taken with Cross Polaroid Filters](image)

With the 20D condensing lens, we were able to obtain about 30 degrees of field of view of the posterior pole (Figure 7, 8, 9).
For viewing retina periphery beyond equator, we detached the instrument from the slit lamp and used the handheld method (Fig 10).

By taking 2 similar images from slightly different angles, we were also able to obtain stereo fundus photographs for depth perception (Figure 11).
DISCUSSIONS

With the smartphone fundus camera adapter, we obtained excellent quality images of the posterior pole and retina periphery, including stereo photographs. It is extremely simple to operate once mounted on the slit lamp, and can easily be performed by even junior resident doctors and technicians. It also serves as a good teaching tool for students to demonstrate various ocular fundus pathologies.

Moreover, most commercially available fundus cameras are out of the reach of many practitioners and institutions due to their high cost. Our smartphone adapter proves to be an extremely cost effective alternative to these imaging devices, retaining the same image quality. The differences between our instrument and the commercial fundus cameras available are summarized in Table 1.

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 as a hand held instrument for various screening programmes (Diabetic retinopathy screening, ROP screening, etc).

Finally, the role of smartphones in telemedicine cannot be overemphasized. The use of smartphones for capturing fundus images serves as an extremely efficient way to share and transfer images instantly via social networking media (Whatsapp, Facebook, etc).

Table 1: Fundus Camera Our Mobiret Cam

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<thead>
<tr>
<th>Image Quality</th>
<th>Good</th>
<th>Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central reflection</td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td>Image orientation</td>
<td>Erect</td>
<td>Inverted</td>
</tr>
<tr>
<td>FFA</td>
<td>Can be done</td>
<td>Needs further research and innovation</td>
</tr>
<tr>
<td>Cost</td>
<td>Costly</td>
<td>Extremely cost effective</td>
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CONCLUSIONS

By making a simple and cost effective fundus camera adapter, we could maximize the potential of smartphones to capture high quality fundus images which are comparable to those obtained from commercially available fundus cameras.

REFERENCES


