OptiCard: An Inexpensive and Portable Method of Bedside Direct Fundoscopy

Muhammad Tauseef Omer and Efra Abbas

ABSTRACT

The use of fundoscopy to observe and grade retinal changes in diabetes and hypertension is well known. Fundus screening is recommended prior to discharge of every neonate from the neonatal unit to rule out congenital cataract. However, the traditional direct fundoscopes are expensive and, therefore, not available in majority of the hospitals in developing countries. Also, fundoscopy needs special expertise to use the device. OptiCard is an inexpensive new method of direct fundoscopy that allows visualization of retina and optic disc with or without the use of cell phone. The affordability and ease of use of this device can result in better patient care in hospital setups with limited resources.

Key Words: *Direct fundoscopy. Wallet fundoscope. Smart phone fundoscope. Fundos screening.*

INTRODUCTION

Fundoscopy is widely done worldwide to observe and grade retinal and optic disc changes in diabetes, hypertension and raised intracranial pressure. Fundus screening is also a recommended part of neonatal physical examination to see red reflex that rules out congenital cataract.[1] The devices used for fundoscopy are expensive and require degree of expertise to be able to visualize retina and the optic disc.[2] Over the years, many methods have been introduced to let physicians visualize fundus without any additional expertise. These include use of a condense lens placed in front of eye and visualizing retina through cell phone camera,[3] placing light emitting diode (LED) just close to cell phone camera and viewing retina on cell phone display,[4] use of prism and reflector placed in front of cell phone camera to guide light rays towards camera.[5] All these methods allow physicians to capture images or make video on a cell phone but these methods either require additional optics to be attached to a cell phone or do not work at hand-held position without a cell phone. The new technique introduced here allows physicians to visualize fundus with or without a cell phone and the device can be placed in a wallet or purse with ease.

Instrument design: The instrument is a set of components installed on a plastic card (Figure 1). A Surface-Mount-Device (SMD) white Light Emitting Diode (LED) of 3.0 Volts is used as a light source; and with copper wires, it is connected to a 3 Volt button cell through a push button that turns it ON when pressed (Figure 2). The button cell is replaceable. LED is attached to the edge of the card whose upper piece can be flipped over to the back (Figure 2). The upper piece has an aperture for direct fundoscopy. The device is named OptiCard. OptiCard may be used with cell phone camera or fundal examination may be done with naked eye.

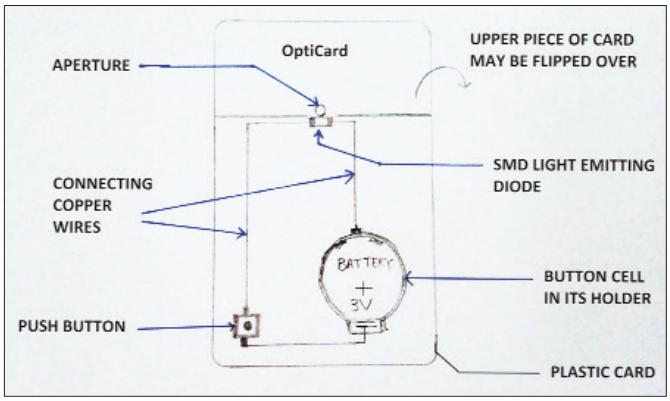

Figure 1: illustration of the concept of OptiCard.

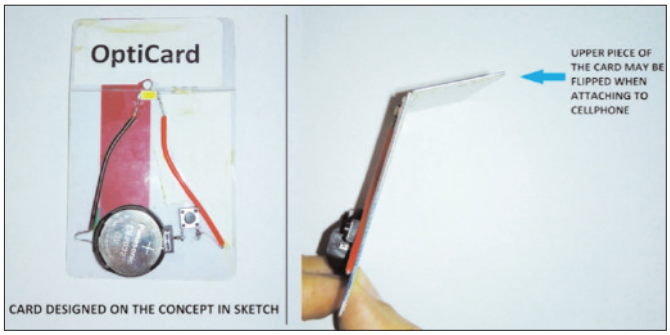

Figure 2: The upper piece may be flipped over to attach to cellphone.

METHODOLOGY

Technique to use with naked eye: The push button is pressed and it turns ON the LED. Patient's pupil (dilated

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Figure 3: Direct fundoscopy demonstration – Card may be used without a cell phone to directly visualize retina.

already with a mydriatic drug) is examined through the aperture of the OptiCard. From a distance of half meter, red reflex may be seen. Bring the card closer to eye till retinal vessels are visualized and follow them converging to the optic disc (Figure 3). The fundus is visualized much easily than with traditional direct ophthalmoscope, as explained in the discussion.

Technique to use with a cell phone: To view fundus through a cell phone, the upper piece of card is flipped to the back and the upper border of the card (with LED on its edge now) is placed close to the cell phone camera, aligning it to the center of the camera lens (Figure 4). Camera is turned ON in the cell phone and by seeing on LCD, the LED is adjusted such that it is just visible through the cell phone LCD. The card may be secured on the cell phone using sticking tape.

Push button is pressed on the card that turns-on the LED, and from half a meter distance a dilated pupil is visualized that may show a red reflex, if present. Cell phone camera is brought closer to the eye about half an inch away from it and retinal vessels get visualized, which may be followed towards the center to visualize the disc. Video or still images may be taken. If the inbuilt camera software of the phone allows 'manual focusing', sharpest images may be taken in myopic or hypermetropic patients.

With practice, fundus and retina may be explored through undilated pupils also.

If the OptiCard is attached to silicone cover of cell phone, the cover may be simply detached from the phone, and attached again once needed.

Figure 4: Card is fixed to cell phone (using sticky tape) by approximating edge of card to the lens of camera.

RESULTS

The images captured through the cell phone are shown here:

Figure 5: Red reflex - Image captured with cell phone camera with OptiCard attached to it that shows red reflex, illustrating that the media of eye from cornea to retina is clear.

Figure 6: The images show healthy retinal vessels photographed using OptiCard. Whole retina (except the peripheral retina, same as the limitation of traditional direct fundoscope) may be visualized using OptiCard; and photos may be taken or video may be captured for record purposes or for image-follow-up.

Figure 7: Healthy Optic disc with well defined margins in above images. Papilledema and optic atrophy are ruled out.

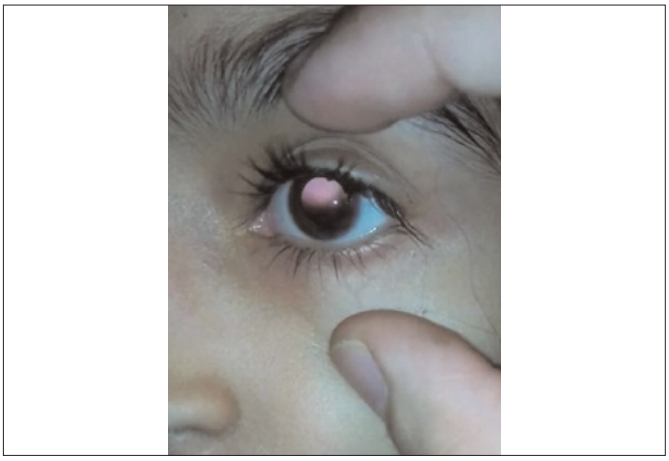

Figure 5: Red reflex – Image captured with cell phone camera with OptiCard attached to it that shows red reflex, illustrating that the media of eye from cornea to retina is clear.

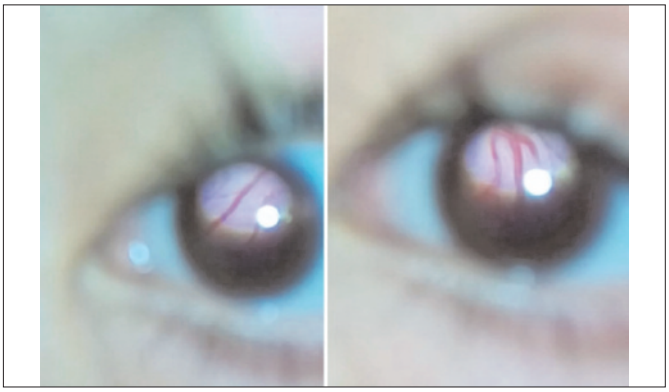

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Figure 7: Healthy optic disc with well defined margins in above images. Papilledema and optic atrophy are ruled out.

DISCUSSION

The traditional direct fundoscope requires experience to instantly visualize the retina and the fundus. Hence, it becomes more problematic in uncooperative patients such as the children in whom the bedside fundus examination may be essential in emergent cases to rule out raised intracranial pressure or in neonates to visualize red reflex to rule out congenital cataract. Traditional direct fundoscopes have light source with reflecting mirror placed about 1 cm away from the aperture for viewing the eye. So in unexperienced hands, a little rotation of the scope causes the axis of the viewing eye and the light source axis to go out of alignment, making the first experience of doing direct fundoscopy a very hard business (Figure 8).

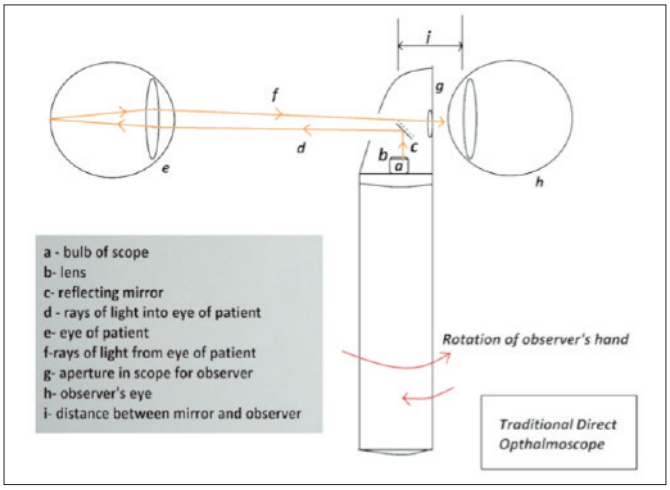

Figure 8: The physics behind Traditional Direct Opthalmoscope. A little rotation of observer's hands causes the rays of light going into patient's eye (d) and hence returning from patient's eye (f) to miss-align with observer's eye (h) resulting in a failed technique.

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With a little rotation of observer's hand (whose eye remains still), the light source of traditional direct fundocope also rotates. And hence the whole path of light rays going into patient's eye and returning back from retina changes, and observer is unable to align with those (collimated) rays.

In OptiCard, as the light source and the aperture for examiner's eye are placed just next to each other (Figure 9), the axis of light and the viewer's eye align by themselves allowing everyone to visualize the retina in the first go; and with a little time spent visualizing retina, one may easily learn how to explore it and examine the disc.

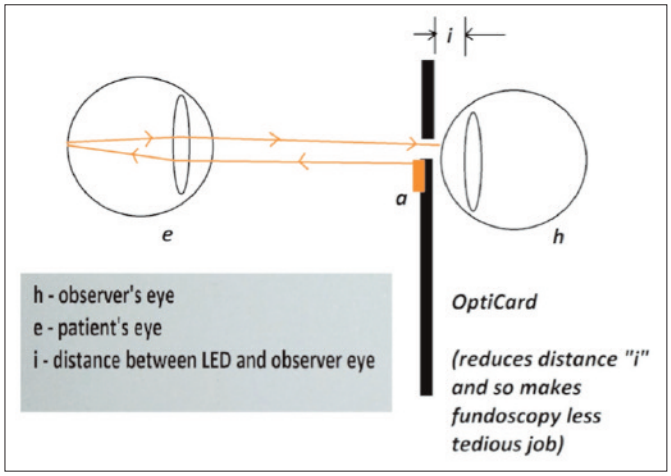

Figure 9: OptiCard reduces the distance "I" and makes fundoscopy easier.

Opthalmoscopes are expensive gadgets. However, the card is much more economical, and may be placed in the wallet. Also, the ease with which a cell phone imaging may be done is a plus-point. The digital opthalmoscopes are long known for their high costs. The concept of OptiCard is easy to execute and requires no additional optics. The previous inexpensive methods of direct fundoscopy allow visualization using a cell phone but none allows visualizing it with the naked eye. OptiCard allows fundoscopy without cell phone also.

OptiCard has its limitations as those of traditional direct fundoscopy, as the peripheral retina cannot be visualized. In Opticard, there is no convex and concave lens focus ring so visualizing retina in a myopic or hypermetropic patient may not be possible. This issue may be partly solved by the use of manual focus feature in smartphone cameras. The more portability awarded by OptiCard at affordable cost could lead to better bedside patient care.

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