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Smartphone Assisted Slit Lamp Free Anterior Segment Imaging: A novel technique in teleophthalmology☆

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With the invent of smartphones with high-tech modalities and their easy access to the internet facilities and development of social networks with the ability to share images in a distinct group of related users for rapid distribution of information and getting their comments and manufacture of high resolution cameras on them a great revolution in telemedicine for photo-documentation and expert consultation has been emerged. Photo-slit images has been widely used for documentation of anterior segment pathologies for preparing power point files for training residents, conferences, symposiums, publishing scientific papers and academic books. However, not all slit lamps are equipped with image recording instruments and there is not any available slit lamps in rural areas in developing countries and in emergency situations. Therefore, applying an alternative feasible modality for photo-documentation of the anterior segment and sharing them with experts for case-based decision making is appreciated. The adoption of the smart phones allows health care practitioners and even patients themselves to easily prepare photographs and videos of the eye records when slit lamp is not available [1–5].

Although the slit lamp images are more informative, this setting with slit lamp free smartphone assisted images are designed for situations that photodocumentation with slit lamp is not available especially in rural areas in developing countries.

Herein, we introduce a user-friendly technique to simplify the eye anterior segment image capture with a smartphone that does not require slit lamp or specialized training.

An i-phone 6 with ios operating agent (Apple® company, California, USA) was used for imaging. The camera was approximated to the eye as close as the brightest and most clear feasible image is formed on the LED display of the smartphone. A photo without additional lens (Fig. 1) and then a photo with a 10 Diopter macrolens (Fig. 2) held on the center of the camera lens were obtained from the eye. Then, a 90 Diopter Volk® (Volk Optical, Inc., Mentor, OH, USA) non-contact slit lamp double aspheric lens was held by the other hand of the operator on the center of the lens of smartphone camera) (Fig. 3). Alternatively,any smart phone with resolution of at least 8 megapixel can be applied by holding the lens manually as described above or attaching the 90 Diopter lens by a clear tape. Then it should be closed to the eye as near as the most clear image is formed on the LED monitor of the smartphone camera. The camera setting is maintained on “keep Normal Photo”. Then the image is captured (Fig. 4).

The close-up image with no additional lens was not so clear and did not show the anterior segment details as seen in Fig. 1. However, the photo with the 10 Diopter lens showed well the lids, medial and lateral cantus and the conjunctiva, limbus, cornea, iris and pupil, however, the details of the anterior segment namely cornea and iris crypts were not evaluable (Fig. 2). The detailed high resolution photos were obtained by 90 Diopter lens which showed the details and even the iris crypts for slit lamp-free anterior segment examination (Fig. 4). Although the slit lamp images are more informative,this setting with slit lamp free smartphone assisted images are designed for situations that photodocumentation with slit lamp is not available.

New generation of smartphones are available even in developing countries with low socioeconomic status. While various adapters have been designed to attach a smartphone to a slit lamp to obtain clinically useful photos, a very simple technique for practitioners to achieve acceptable anterior segment images using only their existing smartphones with no additional accessory or hardware is welcome [2].

The focal length of the 90 Diopter lens is approximately 1.1 cm so the device is held adjacent to the patient’s eye in this depth of the field. It can be easily held in contact with the smart phone lens camera to get informative photos of the anterior segment of the eye.

High resolution informative photos can be saved from the ocular surface, cornea, iris, and lens without the need for a slit lamp. It can easily show the ophthalmic care practitioner the status of the normal and pathologic conjunctiva, cornea, anterior chamber and lens. It can be saved in the smartphone for photo-documenting the patients or easily transferred via email or social networks for teleophthalmology surveys. It can also be analyzed further with image analyzers such as ImageJ® analysis software program (National Institutes of Health (NIH), Bethesda, Maryland, USA) for research purposes especially for experimental models and in the wet labs [5].

This may be also useful for all ophthalmic care providers including ophthalmologists to simply have an anterior segment examination where slit lamp is not available or for bed ridden or hospitalized patients. It may also help to have images of the patients’ eyes by ophthalmic residents and nurses to inform the expert ophthalmologists via email or social networks and also may help run teleophthalmology surveys with no additional cost or equipment in various settings.

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Fig. 1. Smartphone assisted anterior segment photography without macrolens showing vague and hazy image of the eye.

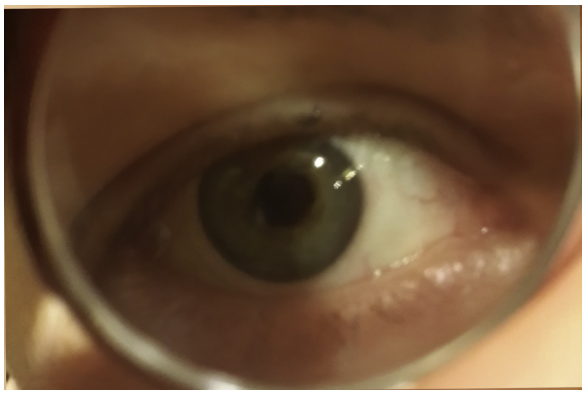

Fig. 2. Smartphone assisted anterior segment photography with macrolens 10 Diopters lens showing clear image of the lids, conjunctiva and corneal clarity, however, details cannot be seen.

Fig. 3. The 90 Diopters lens held manually to the center of lens camera of the smartphone (iPhone 6).

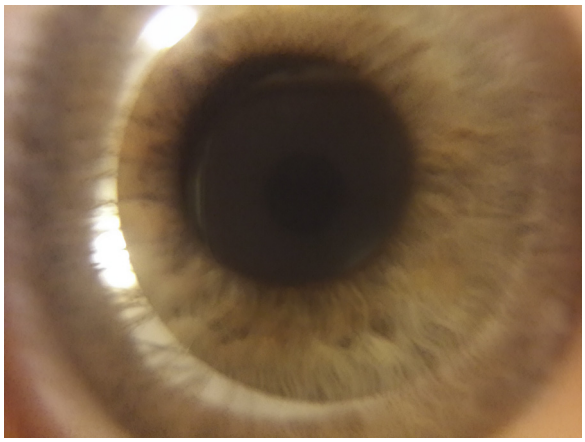

Fig. 4. Smartphone assisted anterior segment photography with macrolens 90 Diopters lens showing cornea and anterior segment clarity.

In conclusion, slit lamp mounted and slit free smartphone-assisted anterior segment imaging was performed successfully with special adaptors and hard wares, recently. This is the first time applying 10 and 90 Diopter lenses commercially available in ophthalmic settings with no further cost for slit lamp-free smartphone-assisted anterior segment imaging for teleophthalmology. In future work, we plan to invent systems with artificial intelligent for non-ophthalmologists and even the patients themselves to evaluate their potential use in developing countries,inpatient consults on emergency situations such as traumatic eye insults and post-operative complications such as post-refractive surgery keratitis and post-cataract surgery endophthalmitis before visiting by the surgeon for the need of urgent referral and starting an empiric therapy if needed, especially where access to an ophthalmologist is limited.

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