The Gimbalscope – A novel smartphone-assisted retinoscopy technique

Prithvi Chandrakanth, Hirika Gosalia¹, Shishir Verghese, Kalpana Narendran¹, Venkatapathy Narendran

Retinoscopy is an objective refraction technique to estimate a person’s refractive error and is the primary and integral step to a complete ocular examination.[1] The accuracy of retinoscopy is highly dependent on the skill of the ophthalmologist or optometrist and is of critical importance especially in assessing the refractive error of infants and mentally handicapped patients.[1,2] Despite the presence of excellent literature and animated videos on the retinoscopy technique, learning this art is a challenge as there is no simultaneous observation of the retinoscopic reflex obtained from the patient’s eye by the mentor and the observer and hence requires intensive instruction.[3] Previous techniques of retinoscopy teaching included its practice on schematic eyes, model eyes, and the use of retinoscopes incorporating a teaching attachment and television retinoscopy.[1‑4] The last two methods allowed the simultaneous viewing of the retinoscopic reflexes by the mentor and the observer. Smartphones are now used widely in ophthalmology especially for imaging the anterior and posterior segment pathologies and are of immense help as a teaching tool and in the field of tele-ophthalmology.[5‑7] We describe a frugal technique of retinoscopy where we attach the retinoscope to the smartphone camera with the help of adaptors for simultaneous viewing and recording of the subject’s retinoscopic reflexes. This novel technique should be useful for learning and teaching basic techniques in retinoscopy and enabling those who have already gained mastery of the fundamentals of retinoscopy to further learn the intricacies of the art.

Innovation

The objective of providing a smartphone attachment to the retinoscope was to enable both the mentor and the observer to see exactly the same image of the retinoscopic reflex, thereby fabricating a retinoscopy teaching tool.

Commercially available smartphone holder clamps were attached together using cyanoacrylate super glue. Additionally, rubber bands were tied so as to make the holder clamp attachment stronger. A smartphone (IOS operating agent – iPhone 5s; Apple, Los Altos, CA) was attached to one of the clamps. A metal smartphone mount holder (with its clamp removed) was passed through the battery hand piece of the retinoscope (HEINE line retinoscope Beta 200, HEINE Optotechnik, Gilching, Germany). The clamp with the smartphone attached to it was then connected onto the smartphone mount holder which was already secured to the retinoscope battery hand piece. The smartphone camera is then aligned to the eyepiece of the retinoscope, and the whole setup is reinforced (gimbalscope) [Figs. 1 and 2]. The smartphone camera zoom option was used to focus and magnify the retinoscope light beam as well as the reflex. Neutralization was performed at a normal working distance [Fig. 3]. Retinoscopic reflexes were elucidated and recorded from 40 eyes of 20 patients including eight eyes of four pediatric patients. An Ethics committee approval was obtained prior to utilizing this technique.

Key words: Innovation, retinoscopy, smartphone, streak retinoscope
Discussion

The use of mobile ophthalmic imaging devices has been an asset in revolutionizing ophthalmic care with the incorporation of smartphones having taken a major leap over the past decade.\cite{5,8} Smartphones can be utilized by the ophthalmologist for a broad range of purposes including patient education, decision support tools, and information and picture/video...
Through these functions, smartphones are able to provide point-of-care access to a wide variety of tools to complete tasks that otherwise may require additional resources and time or may not be possible at all, particularly in under-resourced settings. Additionally, smartphones have also emerged as ophthalmic or optometry resident teaching tools wherein the ophthalmic photographs or videos procured could be utilized and shared online for case-based discussions, specialist opinions on diagnosis and management, and academic presentations. The utility of smartphones has broadened onto the practice of retinoscopy, which is the basic refraction technique routinely utilized by all ophthalmologists and optometrists for clinical refraction. Retinoscopy is a difficult art to teach and practice; hence, various modifications and attachments to the retinoscope have been conceived throughout the history in order facilitate the ease of teaching with smartphones being the latest to enter the fray. Chan et al. created a digital retinoscope by directly attaching a smartphone onto the retinoscope with the help of a reusable putty-like pressure sensitive adhesive. They were able to document normal and abnormal reflexes and use it as a teaching tool. However, because of an older smartphone model, the camera under-performed under low-light conditions. Their report did not mention about the reversibility of their setup. Schrimpf et al. demonstrated smartphone-assisted retinoscopy and were able to record and document high-resolution video clips on the artificial eye as well as the patient’s eye. Their experimental setup involved a smartphone reversibly attached onto a retinoscope via a coupling plate, and furthermore, the retinoscope battery handpiece was connected to a three-axis gimbal, thereby allowing the unit to be rotated in all axes. Additionally, they also utilized a piece of software to remove motion artifacts. They emphasized on the real-time presentation of the retinoscopy reflex to both the mentor and the student. Their setup however seemed complex, expensive, and difficult to be utilized in under-resourced hospitals or secondary setups. Mülhaupt et al. in their pilot study compared a conventional retinoscope (HEINE line retinoscope Beta 200, HEINE Optotechnik, Gilching, Germany) to a video retinoscope prototype with a touch display (HEINE, Optotechnik, Gilching, Germany) and did not find any significant difference between both of them in terms of ease of usability. Our smartphone-assisted retinoscopy setup is assembled out of readily available materials and is reversible and relatively inexpensive. The smartphone has no direct attachment with the head of the retinoscope. Normal and abnormal retinoscopic reflexes obtained were clear, and the smartphone zoom could be used to digitally magnify them at the same working distance. Our setup is of immense benefit to beginners as they can better understand the retinoscopy phenomena and observe it along with the mentor in real time as well as utilize the recorded videos in identifying and appreciating abnormal and subtle retinoscopic reflexes. Our novel approach to retinoscopy provides a convenient, inexpensive tool to assist
the teaching of medical students and residents and for a second opinion. The recorded video clips of the reflexes, including difficult-to-interpret reflexes, could be utilized for observation and discussion with a senior at a later time. Ophthalmologists and optometrists in primary or secondary setups can easily utilize our apparatus as a teaching tool. Our technique is not without its limitations, which include an initial learning curve to attach the adapter to the retinoscope, an increased weight of the overall apparatus due to attachment of the smartphone, a time delay of 3–6 minutes to appreciate the retinoscopy reflex, and a ±0.25D refractive error in the initial few cases compared without smartphone use.

Conclusion
To conclude, we introduce a novel and relatively inexpensive smartphone-assisted retinoscopy apparatus which can clearly record and document the retinoscopy phenomena, thereby being of immense help as a teaching and learning tool.

Declaration of patient consent
The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) have given his/her consent for the images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

References
1. Fukuhara J, Miller KM, Vega C, Guyton DL. A teaching attachment for retinoscopy. Ophthalmology 1987;94:28-30.
2. Wessels GF, Oeinck C, Guzek JP, Wessels IF. A home-made model eye for teaching retinoscopy. Ophthalmic Surg Lasers 1995;26:489-91.
3. Miller KM, Simons K, Guyton DL. Television retinoscopy with a slit-aperture retinoscope and a highly sensitive camera. Ophthalmology 1987;94:22-7.
4. Donovan L, Brian G, du Toit R. A device to aid the teaching of retinoscopy in low-resource countries. Br J Ophthalmol 2008;92:294-4.
5. Pujari A, Saluja G, Agarwal D, Selvan H, Sharma N. Clinically useful smartphone ophthalmic imaging techniques. Graefes Arch Clin Exp Ophthalmol 2021;259:279-87.
6. Chandrakanth P, Nallamuthu P. Anterior segment photography with intraocular lens. Indian J Ophthalmol 2019;67:1690-1.
7. Chandrakanth P, Ravichandran R, Nischal N, Subhashini M. Trash to treasure retcam. Indian J Ophthalmol 2019;67:541-4.
8. Hogarty DT, Hogarty JP, Hewitt AW. Smartphone use in ophthalmology: What is their place in clinical practice? Surv Ophthalmol 2020;65:250-62.
9. Chan WO, Crabb M, Sia D, Taranath D. Creating a digital retinoscope by combining a mobile smartphone camera and a retinoscope. J Am Assoc Pediatr Ophthalmol Strabismus 2014;18:387-8.
10. SchrirmpfB, Dalby M, MühlhaupM, Michel F, Holschbach A, Schiefer U, et al. Interaktives training mittels smartphone-videoskiaskop: Videobeitrag. Ophthalmol 2020;118:384-8.
11. Mühlhaup M, Michel F, Schiefer U, Ungewiss J. Vorstellung eines neuartigen Videoskiaskops: Einsatz von konventionellem Skiauskop und Videoskiaskop in der Lehre – eine vergleichende Pilotstudie. Ophthalmol 2021;118:854-8.