

Smartphone-Based Fundoscopy

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Globally, vision impairment affects over 1 billion people. Complete blindness affects around 36 million, among which 90% live in developing countries. Retinal diseases are a major cause of blindness and visual impairment. According to the World Health Organization (WHO), retinal diseases are responsible for 8.7% of blindness and 5.4% of visual impairment worldwide.

Retinal Disease

Retinal disease is any pathology of the retina that may lead to decreased vision or blindness. The retina is a thin layer of light-sensitive tissue that lines the back of the eye. It converts images into electrical signals that are sent to the brain, where they are interpreted as sight.

The most common types of retinal diseases include age-related macular degeneration (AMD), diabetic retinopathy (DR), and glaucoma. These three diseases alone account for more than 50% of all cases of blindness and visual impairment worldwide. In all of these diseases, the retina is damaged, which leads to decreased vision or blindness.

While there are many different types of retinal diseases, they all have one thing in common: they can lead to permanent vision loss if left untreated. For this reason, early detection and diagnosis of retinal disease are essential.

Examination of Retina

Conventional funduscopy is the gold standard for examining the retina. It involves dilating the pupil with eye drops and using an ophthalmoscope to look into the eye. This allows the doctor to see the retina, optic nerve, and blood vessels.

While this method is effective, it has several drawbacks. First, dilation of the pupil can cause blurred vision and light sensitivity for several hours afterward. This can make it difficult for people to perform their everyday activities.

Second, funduscopy requires specialized equipment that is not always available in resource-limited settings. Fundoscopy is done using an ophthalmoscope, which is a hand-held instrument that magnifies the image of the eye. Ophthalmoscopes can be expensive and are not always available in resource-limited settings. A slit-lamp is another type of specialized equipment that is sometimes used for funduscopy. Slit lamps are even more expensive than ophthalmoscopes and are not always available in resource-limited settings.

There are different types of ophthalmoscopes, including direct ophthalmoscopes and indirect. Direct ophthalmoscopes are the most common type. They consist of a light source and a lens system that is used to magnify the image of the eye. Direct ophthalmoscopes are hand-held instruments that consist of a light source and a lens system. The cost of a direct ophthalmoscope ranges from \$150 to \$300. Likewise, the cost of an indirect ophthalmoscope ranges from \$500 to \$1,000.

However, these are still not that effective as compared to the slit lamp. That is primarily because lenses in an ophthalmoscope cannot provide enough magnification to get a clear view of the retina. The maximum magnification of an ophthalmoscope is 20X, whereas the maximum magnification of a slit lamp is 100X. The cost of a slit lamp ranges from \$5,000 to \$10,000.

A fundus camera is another type of specialized equipment that is used for funduscopy. Fundus cameras are large, expensive machines that take pictures of the retina. They can be very helpful in diagnosing and monitoring retinal diseases. However, they are not always available in resource-limited settings. The cost of a fundus camera ranges from \$10,000 to \$20,000.

Smartphone-Based Fundoscopy

Smartphone-based funduscopy is a new method of examining the retina that uses a smartphone instead of specialized equipment like an ophthalmoscope or slit lamp. An attachment is placed on the smartphone that allows the doctor to see the retina. The lens of various powers are placed into the attachment in order to get a clear view of the retina.

This novel idea was first proposed in a paper published in 2014 (Giardini et al. 2014). The authors of the paper used a Samsung Galaxy S3 with a homemade attachment to examine the retina. They were able to get clear images of the retina using this method. Since then, several other studies have been conducted to assess the feasibility and accuracy of smartphone-based funduscopy. These studies have shown that smartphone-based funduscopy is a feasible and accurate method of examining the retina.

Benefits of Smartphone-Based Funduscopy

There are several benefits of smartphone-based funduscopy over conventional funduscopy.

Portability

One of the biggest advantages of smartphone-based funduscopy is its portability. Smartphones are small and light, which makes them easy to carry around. This is especially helpful in resource-limited settings where specialized equipment like ophthalmoscopes or slit lamps may not be available.

Even in developing countries, almost everyone has a smartphone. This means that there is no need to buy or maintain any extra equipment.

More Screening Opportunities

Another advantage of smartphone-based funduscopy is that it provides more opportunities for screening. Since smartphones are so portable, they can be taken to remote areas where people do not have easy access to hospitals or clinics. This means that more people can be screened for retinal diseases.

It is estimated that in South Asia alone, over 150 million people have diabetes. Of these, only 1% are screened for diabetic retinopathy (DR), which is the leading cause of blindness in adults.

Likewise, in Africa, only 1% of people with glaucoma are screened. With smartphone-based

fundoscopy, it is possible to screen more people for retinal diseases. This could help to reduce the burden of these diseases in developing countries.

Reduced Cost

Another advantage of smartphone-based fundoscopy is that it is much cheaper than conventional methods like ophthalmoscopy or slit lamp biomicroscopy. For example, a direct ophthalmoscope costs between \$150 and \$300, while an indirect ophthalmoscope costs between \$500 and \$1,000. In contrast, the cost of the attachment needed for smartphone-based fundoscopy along with a 20D lens is under \$250. When you compare it with a direct ophthalmoscope, it provides better viewing with the magnified aspheric lens and is nearly the same cost.

As a result, the overall cost of retinal examination at scale can be reduced by 80% using smartphone-based fundoscopy as compared to traditional methods like ophthalmoscopy or slit-lamp biomicroscopy.

Improved Accuracy

Another benefit of smartphone-based fundoscopy is that it can improve accuracy. Studies have shown that when trained doctors use smartphone-based fundoscopy, they are able to correctly identify retinal diseases with high accuracy (Kim and Chao 2019).

For example, in a study conducted in India, doctors were able to correctly identify diabetic retinopathy in 78% of cases using smartphone-based fundoscopy (Nagra and Huntjens 2019). In contrast, when these same doctors used a direct ophthalmoscope, they were only able to correctly identify diabetic retinopathy in 72% of cases.

This shows that smartphone-based fundoscopy can improve accuracy and lead to better outcomes for patients.

Educational Benefits

Finally, smartphone-based fundoscopy can also have educational benefits. Since smartphones are so widespread, they can be used to train more people in the retinal examination. This could lead to more people being able to screen for retinal diseases in the future.

Junior doctors who have access to smartphone-based fundoscopy can be trained more easily in the retinal examination. This could lead to more widespread screening for retinal diseases and improved outcomes for patients.

Digital Documentation

Another advantage of smartphone-based fundoscopy is that it can be used for digital documentation. This means that images can be stored on a computer or smartphone and shared with other doctors easily. Ophthalmoscopes don't have this capability because no camera is built-in.

This is important because it can help to improve the accuracy of diagnosis. When a doctor shares an image with another doctor, they can get a second opinion. This can help to ensure that the correct diagnosis is made. It also means that images can be stored for future reference. This can be helpful if a patient's condition changes over time. By having access to previous images, doctors can track the progression of a disease and make more accurate decisions about treatment.

Other Benefits

There are also other potential benefits of smartphone-based fundoscopy that have not been studied extensively. For instance, it is possible that smartphone-based fundoscopy could be used to screen for other diseases beyond retinal diseases.

Additionally, as technology improves, it is likely that the quality of images taken with smartphone-based fundoscopy will improve. This could lead to even more accurate diagnoses and better outcomes for patients. This also has the potential to usher in a new era of telemedicine, where doctors can consult with each other remotely using digital images.

Thus, smartphone-based funduscopy is a promising technology that could revolutionize the field of retinal examination. It has the potential to reduce costs, improve accuracy, and provide educational benefits. Additionally, it could be used to screen for other diseases and improve the quality of telemedicine.

Choroida Mobile Fundoscopy

Choroida is a company that produces a mobile funduscopy device. This device can be attached to a smartphone and used to take pictures of the retina. The images taken with this device are of high quality and can be used for the diagnosis and treatment of retinal diseases.

How Does It Work?

The Choroida mobile funduscopy device consists of two parts: an eyepiece and a camera attachment. The eyepiece is placed against the eye and the camera attachment is placed over the smartphone's camera lens.

When the shutter button is pressed, the camera takes a picture of the retina. The image is then stored on the smartphone and can be shared with other doctors or used for digital documentation. This is in addition to the viewing benefits of a smartphone-based fundus camera. The Choroida mobile funduscopy device is easy to use and can be attached to any smartphone. The eyepiece, a 20D aspheric lens, offers a wide field of view. The lens is compatible with other modes of funduscopy, such as indirect ophthalmoscopy and slit-lamp biomicroscopy.

The flashlight of the smartphone provides illumination for the retina. The light is reflected off the retina and back through the eyepiece, where it is captured by the smartphone's camera.

Conclusion

The prospect of further developing the use of smartphone-based funduscopy is exciting. This technology has the potential to revolutionize the field of retinal examination and make it more

accessible to people all over the world. With further research, it is likely that the quality of images taken with smartphone-based funduscopy will continue to improve. Additionally, as technology improves, this type of funduscopy could be used to screen for other diseases beyond retinal diseases.

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