The scanning laser ophthalmoscope: a new view on the retina

Observation of the retina provides the observer with a sneak view of the central nervous system. Where else can one observe neural tissue over periods of weeks or even years? However, simply looking into the eye does not reveal the retina.

Leeuwenhoek observed many cells and tissues in the body, but his single lens microscope did not permit observation of the retina in vivo. Instead, he had the excitement of using his microscopes to observe the structure of the corneal epithelium, the lenticular fibres of the ocular lens, as well as striated muscle, red blood cells, and bacteria.

It took a mathematician, Charles Babbage, to design a direct view ophthalmoscope. The world still had to wait another five years for Helmholtz, in 1850, to introduce a practical device to permit the clinician to observe the living retina. Soon afterwards he introduced the indirect ophthalmoscope. The next major advances in the observation of the living retina were the development of the retinal camera and the technique of fluorescein angiography. These permitted the clinician not only to observe the retina, but also to measure the integrity of the retinal circulation.

Other recent developments in instrumentation have provided new tools to quantitate retinal structure and function. Instruments are now available to measure the thickness of the nerve fibre layer. The topography of the optic nerve head can now be measured. Recently, the three dimensional visualisation of the optic nerve and lamina cribrosa has been accomplished in a live human subject. The retina is becoming clearer and clearer to the clinician with this new technology.

In this issue, Manivannan et al present a clinical investigation of an infrared digital scanning laser ophthalmoscope (SLO). The authors point out that in comparison with conventional fundus photography confocal infrared SLO improves the visualisation of the choroidal vasculature, retinal pigment epithelial abnormalities, laser photocoagulation scars, and optic disc pores in the lamina cribrosa.

The technical advance from the retinal camera to the digital scanning laser ophthalmoscope was a quantum leap forward. While the retinal camera images all points of the retinal region simultaneously or in parallel, the SLO images the region of the retina point by point. This permits observation of the retina with a lower light illumination intensity, permits video rate imaging in reflected light or fluorescence, and shows increased contrast due to the reduction in stray light and scatter from out of the focal plane. The laser which is used for illumination can employ monochromatic light from the visible to the near infrared spectrum. This avoids chromatic aberration. The use of the SLO for fluorescein angiography to study the retinal circulation, and for indocyanine green angiography to investigate the choroidal circulation is a major step towards understanding the blood flow in the retina. In addition, the pigments in the normal and diseased retina can be quantitated with the SLO by reflectometry.

The major problems with the SLO are its limited lateral depth resolution and the aberrations of the eye, while some optical modifications to the SLO have been reported which result in narrow optical section imaging. The next breakthrough in SLO imaging of the retina will be instruments that measure the optical aberrations of the cornea and the lens and correct the optics of the SLO for each individual eye. Then we will truly see the retina.

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