Scanning laser ophthalmoscope

Confocal scanning laser ophthalmoscope (cSLO) was originally developed by Webb et al. using a low-energy laser source to scan the retina in two directions: termed as x and y [(19)].

The confocal nature of the optics ensures that the reflectance and fluorescence correspond to the same focal plane. cSLO overcomes the limitations of the low-intensity signal of FAF and the lens interferences.

The defocused light is almost completely suppressed, thus reducing the autofluorescence from the optical media anterior to the retina, such as the lens or the cornea.

In order to reduce the background noise and to increase the contrast of the image, a series of FAF images are usually recorded[(20,21)].

Following the aligning of the images in order to correct the movement of the eye during the acquisition, the final image is calculated (usually from 4-32 frames) and the values of the pixels are normalised.

The FAF image can be obtained with low excitation energies within the limits of maximum retinal irradiance established by the American National Standard Institute and other international standards[(22)].
cSLO enables the acquisition of FAF images from wide areas of the retina (55º with one frame and even larger areas using the composite mode)[(20,22)].

Although limited by the optical properties of the human eye, SLO succeeds in imaging the posterior pole with a high contrast.

Currently there are three different cSLO systems for FAF imaging: the Heidelberg Retinal Angiograph (HRA) (based on the HRA classic, HRA 2 and the Spectralis HRA) (Heidelberg Engineering, Dossenheim, Germany); the Rodenstock cSLO (RcSLO; Rodenstock, Weco, Düsseldorf, Germany); and the Zeiss prototype SM 30 4024 (ZcSLO; Zeiss, Obercochen, Germany).

HRA is the only currently commercially available system with the cSLO system to capture FAF images.

HRA uses an excitation wavelength of 488 nm from an Argon laser or a solid-state laser. A barrier filter with a short-wavelenght cutoff at 500 nm is inserted just opposite the detector, blocking the laser light and letting the autofluorescent light through.

Recently, it has been made possible to acquire real time images, a technique known as real-time averaging.

The Rodenstock cSLO and the Zeiss prototype SM 30 4024 have also been used to acquire clinical FAF images.

Both systems use an excitation wavelength of 488 nm (the same as the HRA), and barrier filters at 515 nm and 521 nm, respectively[20,21,23].

Bellmann et al. have noticed marked contrast and brightness differences as well as in the grey range (an important marker of the image quality between the different systems of cSLO).

These limitations must be taken into consideration when comparing images from different cSLO systems[24].

The default software of the HRA system normalizes the pixel distribution of the final image in order to improve the distribution of the FAF intensity.

Even though this final step facilitates the evaluation of the localized topographic differences, it allows a relative estimation of the intensities of the FAF.

Thus, it should not be used for quantitative calculation and absolute comparison between different FAF images.

The normalization of the average images can be easily turned off, and brightness and contrast can be manually adjusted to permit an adequate visualization of the distribution of autofluorescence in areas with a very high or very low signal in order to improve the visualization of small details.

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