This chapter describes an approach to introducing modern retinal imaging to the general medical examination of healthy people at public health checkup centers. The human fundus is a well known indicator of vascular disease and aging. The information gained from fundal imaging is obtained using noninvasive techniques without side effects.

Ocular Fundus in Preventive Medicine

Any medical student knows that arterial hypertension, arteriosclerosis, and age in its general biologic sense leave characteristic signs on the ocular fundus. The ophthalmologist is often aware of the remarkable difference between the multiple signs of an “aged” fundus and the chronologic age of the patient.

There is no doubt that ophthalmoscopy can contribute interesting information to the most common questions of healthy people undergoing checkups, including the following: Are there signs of an accelerated aging process? Can the individual reverse such signs by changing his or her life style? Did anything change on the fundi since the last check up? Is the subject’s statistical life expectancy above or below the average?

So far, the ophthalmoscopic knowledge is not used generally for preventive medicine. There are several reasons for this fact.

1. The need for mydriatic drops and their side effects in normal ophthalmoscopy.
2. The need for documentation (photographs).
3. The need for long-term investigation, year by year.
4. The need for closely comparing every photograph to its predecessor.
5. The lack of scientific knowledge about the prognosis of detected small changes on the fundus.
6. The lack of therapeutic consequences on detected fundus aging processes.

Up to now these reasons prevented the widespread diagnostic use of ophthalmoscopy in general medical diagnostics (except screening for diabetic retinopathy).

Nonmydriatic Fundus Imaging and Archiving Computer System

FIACS

Infrared and digital imaging techniques permit fundus imaging without most of the previously cited difficulties. Four of the six points listed above can be overcome with the nonmydriatic fundus imaging system (FIACS). The system consists of the following.

1. An infrared nonmydriatic TOPCON fundus camera where the photographic camera is
combined with a solid state CCD video camera.

2. A computer for input and storage of the electronic images coming from the nonmydriatic fundus camera.

3. A digital image archiving medium able to store and retrieve fundus pictures in a few seconds.

4. A program for image comparison that is capable of image registration and subtraction.

5. A diagnostic key system and database software for statistical evaluation of the data.

**Video Ophthalmoscopy Versus Fundus Photography**

It is important to recognize advantages and disadvantages between video ophthalmoscopy and fundus photography. From the technical standpoint, there is nothing new in replacing the photographic camera attached to the fundus camera by an electronic image sensor. Nonmydriatic fundus cameras already have an incorporated infrared-sensitive video camera for adjusting position, fixation, and focusing on the fundus before taking photographs. A second electronic sensor now replaces the photographic equipment, which normally was a Polaroid camera.

Electronic image sensors have properties that differ from those of photographic cameras.

1. They do not need film and chemical development to produce an image. They deliver immediate images on a television monitor.

2. They are much more light-sensitive than film, and therefore much weaker flash intensities are needed. The patient is not irritated by the intensive light flash, and only minimal dazing occurs. Physiologic mydriasis (which is necessary in so-called nonmydriatic ophthalmoscopy) for taking a picture from the second eye or for taking more than one picture from one eye is not longer a time-consuming process.

3. They have much lower spatial resolution than photographs (same as with any video image compared with a photograph). Therefore they cannot replace photographs. It is not possible to detect suspected microaneurysms in diabetic retinopathy, for example. However, new cameras with 1000- to 2000-line resolution make their detection possible.

4. Normally they have no color (color sensors of good resolution are expensive).

It seems natural to combine photographic and electronic imaging in one nonmydriatic camera in such a way that the investigator can switch between the two methods or use them simultaneously with one single flash illuminating both the photographic film and (much weaker) the light-sensitive electronic image detector.

**Diagnostic Parameters Derived from Fundus Images**

Video ophthalmoscopy has good properties for taking pictures of the location and curvature of the major fundus vessels, the vessels on the optic disc, the homogeneity of the choroidal background, and the pigmentation; but normally they give insufficient information about smaller vessels and absolutely no information about capillaries and microaneurysms. A frequent question concerns caliber changes. There is no doubt that one important sign of arteriosclerosis is the uneven narrowing of arterial diameters. It is complicated to quantify this phenomenon from several photographs taken over a period of years because of the many side effects the patient has experienced, some of which were due to medical reasons (e.g., vasculomotor reactions, lens opacities, refraction changes) and others that derived from the technical side: exposure to light, reflections, and so on.

It is even more difficult to quantify vessel caliber changes on electronic images because of their limited pixel resolution. The consequence is that subtle caliber changes are barely detected on digital images. Whenever they are suspected, manual comparison of photographs