Instruments Commonly Used For Examination of the Eye

There are many instruments that the eye doctor might use to evaluate the eye and the vision system. This report presents some of the more commonly used items and includes some photographs of what this writer uses daily. It is divided into two sections: instruments for the diagnosis of eye health and instruments used to determine the status of the vision system.

Photographs are to help with identification. Models from various manufacturer's may appear somewhat different.

Eye Health Evaluation and Diagnosis

Ophthalmoscope (aahp-thalmo-scope)

There are two kinds of ophthalmoscopes: the smaller hand-help monocular direct (MO) and the larger binocular indirect (BIO). The MO is used to examine the back of the eye; that is, the optic nerve, blood vessels, the macula and the "fundus"---the general term for the back of the eye. The MO allows for a somewhat magnified view with limited viewing field. It can also detect changes in the clarity or obstructions in the normally transparent ocular media. The doctor must locate the instrument within a few millimeters of the pupil for viewing of the back of the eye and about 20-60cm in front for viewing the media.

The BIO is an instrument which is either mounted on the doctor’s head or in a spectacle-type mounting like a virtual reality goggle. It has a separate light source and optical system and is used along with a condensing lens placed in front of the eye. The doctor is positioned in front of the patient usually at a distance of 40-70cm (16-30 inches). Drops are most often used to dilate the pupil. This allows for a stereoscopic (3-D) view of the back of the eye. The image is somewhat reduced in size relative to the MO, but the field of view is far wider, allowing the examination of parts of the eye inaccessible with the MO. The stereoscopic ability also allows for the detection of elevated lesions that might not be apparent with the MO.
The Slit Lamp Biomicroscope

This instrument provides a high magnification view of the front structures of the eye, including the cornea, iris and lens, and with the use of the condensing lens, it allows a detailed, stereoscopic view of the retina. It is used to detect tissue damage to the ocular surface including the cornea (often with the use of yellow fluorescein, red rose bengal or green dye), conjunctiva and lids. It also can detect inflammation of the internal structures, cataract changes of the crystalline lens and more. It is used extensively for the fitting of contact lenses and is the instrument of choice for detecting contact lens related tissue changes to the cornea and surrounding tissues. The Zeiss system (this one of the original Zeiss brand units) is shown on the left, a Haag Streit, a somewhat different design, is the picture on the right. A number of manufacturers make Zeiss-design and Haag Streit-design units.
Most eye doctors use some sort of automated visual field apparatus. Visual field testing is essential in determining retina disease or neurological deficits in the visual pathways between the eye and the brain. It is the primary tool for detecting visual field loss resulting from glaucoma, retinal tears, artery and vein occlusions and tumors along the optic nerve pathway and brain. Pictured here at the left is the Humphrey FDT unit (a recent addition to the ranks of computer-assisted field machines) It offers a very rapid screening protocol and fast full-threshold comparative testing (compared to the other devices). The patient observes an oscillating bar pattern which appears in various locations on a video screen in the unit and indicates that he/she sees the image by pressing a mouse button on a clicker. Other field testers include the "big bowl" and "big box" units by a number of manufacturers. These are larger machines that display individual points of light on the inside of hemispherical shell. The patient sits with his/her head just inside the box and observes the light show and, as with the FDT, indicates seeing the target by pressing a mouse button. For all machines, a software program plots the observed targets in the field and uses a database to compare patient responses to expected age-relative normals.
The Tonometer

This device measures the intraocular fluid pressure. The unit displayed here at the left is a portable version of the Goldmann type tonometer, the "gold standard" for diagnostic testing of eye pressure. Other Goldmann tonometers are mounted on the slit lamp. These units require the use of flourecein dye and, most often, a drop of topical anesthetic. There are a few other tonometers that are in use. Electronic probe contact-type machines are usually wall- or desk-mounted, provide a graphic print-out and do not require a local anesthetic. Another version is a pen-like probe (it looks like an electronic fever thermometer) that provides a digital read-out. Some offices still use the "air puff" non-contact tonometer.

A note about pressure readings as they relate to glaucoma: Approximately 20% of diagnosed glaucoma patients have normal tension glaucoma (NTG). Their pressure appears within the normal range, but nevertheless suffer nerve damage and corresponding visual loss. There is also a pretty sizable population who have measured pressures above the "normal" range but do not have the visual or anatomical signs of glaucoma. Therefore, pressure readings alone are not a reliable method of diagnosing glaucoma. The disease is diagnosed by physical observation of the optic nerve and surrounding nerve fiber layer in the retina and by the analysis of the visual fields. Please see the article on The Glaucomas for more information.

Instruments for the Determination of Refractive Error

Keratometer and Automated Cornea Topographer

The keratometer is shown here. This instrument measures the curvature of the anterior cornea and is also useful in determining the smoothness of the ocular surface. Knowing the curvatures provides important information regarding the degree of astigmatism error. The keratometer is useful in diagnosing
keratconus, a cornea disease, and is vital in the fitting of contact lenses. The automated topographer is an instrument which actually maps out the surface of the cornea, providing many additional data points relating the curvature changes at different locations. This information is displayed on a video screen and can be printed to hard copy. The instrument, not crucial for a standard examination or routine contact lens fitting, is another valuable tool. The automated topographer is very useful in verifying the diagnosis of keratconus and in preparation for laser refractive surgery.

Retinascope

This instrument is used to determine, objectively, the resultant additional lens power which presents the retina with a clearly focused image. In short, it determines the optical prescription with little or no viewer input. The unit projects a light source to the back of the eye as the operator dials in the lens power required to focus that light source correctly on the retina. Many doctors use this test routinely to give a starting point to begin the subjective refraction. This is the comparative "which is better" test which allow the observer to modify the prescription lens power according to real-life and real-time needs.

Autorefractor

The automated refractor is a computer-controlled version of the retinascope and is often used, especially in a clinic or busy office settings. It is not necessarily more or less accurate than the hand-held unit. Unlike the manual unit where the examiner may observe fluctuations in the focusing system, the automated refractor simply averages a number of instantaneous readings. Software adjusts the data and prints out the optical correction. In a stable vision system, this data is highly reliable. In an unstable system, the data can be invalid; usually, the software so indicates.

Either instrument is important in helping to determine the optical status of the eye. They are invaluable when examining non-communicative people, for example young children and disabled adults.
The Aberrometer/autorefractor

This is the Z-View. It not only performs the functions of the autorefractor, but also maps higher order aberrations. This technology powers the “wavefront laser LASIK” systems and can be used to create optical lenses that produce sometimes far sharper, clear and distortion-free optics.

The Refractor/Phoropter

This instrument contains lenses and prisms which, in their various combinations, can reproduce virtually any possible optical correction. Here is where the data from the retinascope or autorefractor is placed and the viewer and the examiner subjectively adjusts the lens powers for optimum usefulness and patient comfort. The patient is asked questions comparing the quality of the vision afforded by two different lenses. The examiner uses this information to fine-tune the lens powers to best suite the patient.

The instrument also contains many other useful lenses. Some can be used to present a double image of the chart, allowing instant comparisons of the vision of the two eyes. Others help determine how the eye muscles respond to the various lenses placed in front of the eyes.

These are the primary large instruments used to examine the eyes. The eye doctor also uses a number of other tools in his/her efforts to determine the health and refractive status of the eye and vision system.

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