# A New VISION TEST

THE EYE NEWSLETTER • VOLUME XXIV • JANUARY, 2001
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We have a new instrument to help screen our patients for ocular and neurological disease. It is called a Flicker Doubling Technology Field Instrument and it is offered as a part of our routine examination; there is no extra charge for it.

## Perimetry and Visual Field Testing

Evaluation of the visual field is useful for detecting ocular disorders that degrade peripheral vision before central vision is affected, such as in glaucoma, retinal disease and neurological disorders. As surprising as it may seem, visual field loss can be significant and still not affect our central or reading vision. The pattern of visual field loss is also useful in defining the site of pathology along the visual pathways and in establishing the proper differential diagnosis.

Because most of us are often unaware of peripheral vision loss, especially if the loss is gradual and only in one eye, a careful history may not help to identify early ocular pathology or yield any significant symptoms experienced. Visual field testing may be the only means of obtaining this information. Finally, monitoring changes in visual field sensitivity over time can be very helpful for monitoring the status of pathologic ocular conditions, and the effectiveness of various therapeutic regimens.

Prior to this new technology, the standard in visual field testing was, and still is, static perimetry.

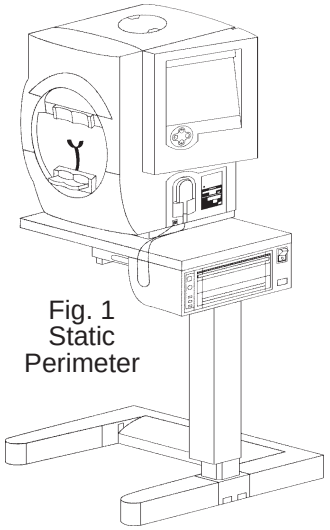

Fig. 1
Static
Perimeter

## Static Perimetry

This a technique in which the patient looks into a white hemispherical bowl (Fig.1) at a small fixation point in the center. This procedure is suited to automated testing, and presently is the most commonly used form of automated perimetry. At fixed, stationary locations in the visual field, stimuli are briefly presented and the patient presses a response button when a stimulus is detected. Typically, the size of the stimulus remains constant and the luminance is varied to define the minimum luminance necessary for detection of the stimulus. That is called the threshold.You can see a printout for a normal visual field in Fig. 2, below. The leftmost figure (A) is a grey map of a normal field. The dark spot toward your the right is called the blind spot. That is where the optic nerve is located and there are no visual cells on the surface of the optic nerve. The second from the left (B) is the actual light responses in decibels. The third and fourth figures (C, D) show any diffferences from a normal field. As you can see, there are no differences.

Because a standardized test procedure is used, databases of normal values for individuals of all ages have been

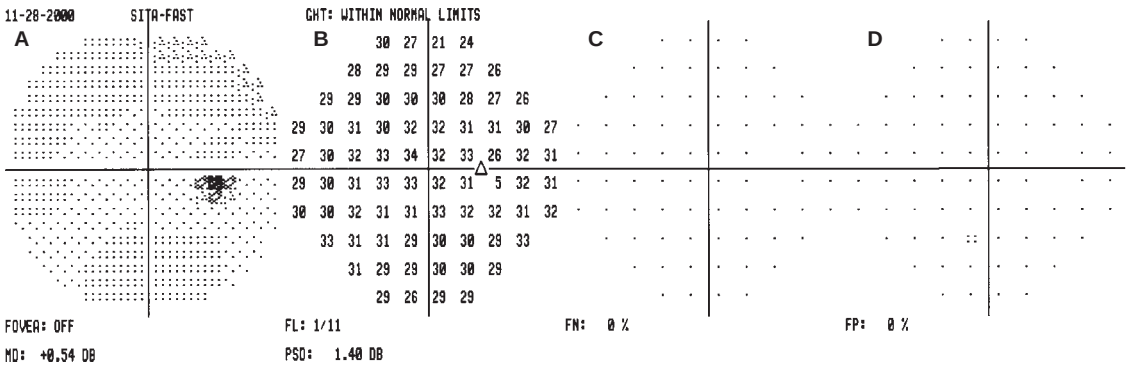


Fig. 2. Static Perimetry showing a normal field for the patient's right eye.

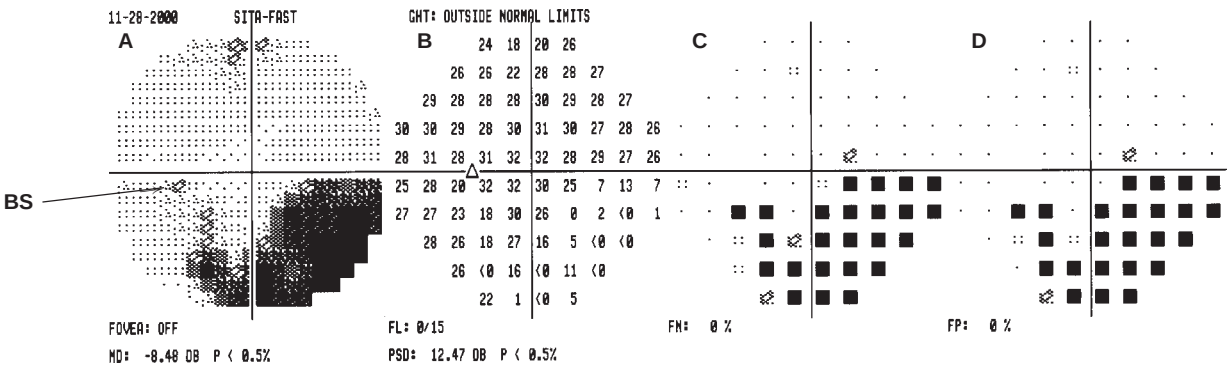


Fig. 3. Static perimetry showing inferior nasal loss. There is an apparent step nasally and an arcuate-like loss that extends downward from the blind spot (BS) and merges with the inferior nasal field loss.

established for automated static perimetry. This allows the examiner to directly compare an individual's test results to age-adjusted normal population characteristics to identify whether various locations are within normal sensitivity limits or whether they are outside of normal limits by a specific amount.

Fig. 3, above, shows a static visual field test for a patient with glaucoma damage in the left eye. The lower, right-side portion of the grey map (A) is mostly black. You can see an arcuate-like defect that extends from the blindspot (towards the side of the head) inferiorly and then merges with the large, nasal (towards the nose) defect. The black marks (C,D) are abnormal retinal locations. Lesser degrees of black show lesser degrees of abnormality. This represents a significant field loss from glaucoma. The third and fourth figures (C,D) show the actual differences from a normal field. The basis for the test results is derived from our knowledge of retinal anatomy.

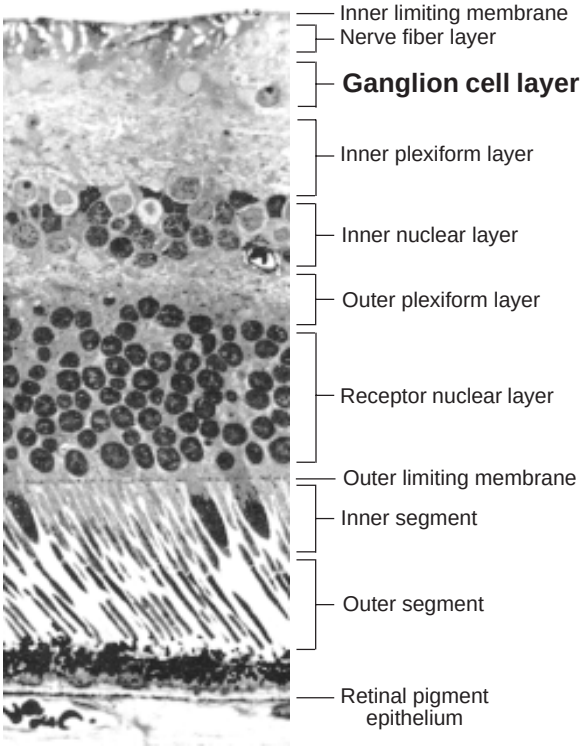


Fig. 4. Retinal Layers - about one millimeter thick

## Retinal Anatomy

Understanding retinal anatomy explains the basis for visual field testing. Fig. 4, to the right, shows the retina to be a very complex layered structure. The cells that respond in visual field testing are in the ganglion cell layer. There are multiple horizontal and vertical associations between the cells; but, basically, each one of these cells is responsible for responding to a certain type of light: color, light vs. dark, and movement. A nerve fiber extends posteriorly to the optic nerve, back to the mid-brain, and then to the brain itself (occipital cortex) where the image is perceived. This means that each ganglion cell reponds to light from a specific spot in your field of vision. If that ganglion cell is damaged, as with glaucoma, it does not respond to changes in light or movement from the spot for which it is responsible. The visual field test attempts to identify both damaged and normal ganglion cells by finding spatially consistent defects in the field of vision.

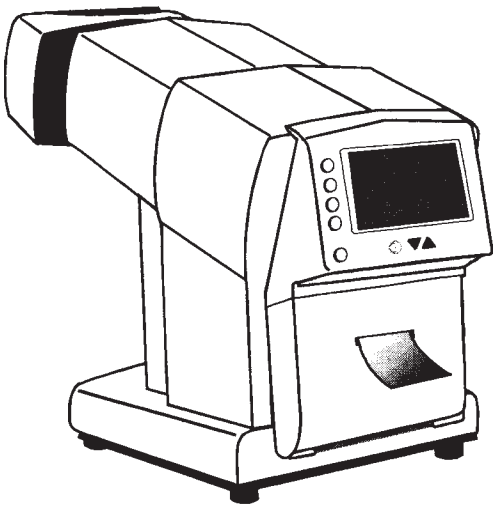

Fig. 5. Flicker Doubling Technology Visual Field Instrument

## Conventional Perimetry

This type of testing is quite nonspecific in its stimulation of various types of ganglion cells and therefore the redundancy present in the visual system makes it difficult to detect the earliest functional losses using this approach. Visual field deficits are detected only after a significant number of ganglion cells have been damaged. Automated static perimetry, in particular, can also be quite demanding for many elderly patients, as it may be a very tedious test. Thus, the goal of new perimetric test procedures is to create procedures that more specifically isolate and evaluate visual mechanisms, better reveal the earliest pathologic changes to the visual system, and decrease the amount of testing time that is required for perimetric evaluation of the visual field.

In an attempt to address some of the shortcomings of conventional perimetry, a number of new approaches to perimetry and evaluation of peripheral visual function have been developed that apply more sophisticated methods of evaluating the visual system. These tests are designed to evaluate specific subgroups of ganglion cells with special response properties (e.g., sensitivity to motion, flicker, color) that may be useful in revealing early visual function losses produced by ocular or neurologic disease. **Frequency Doubling Technology** represents one of these new test procedures. It specifically evaluates mechanisms that are responsive to high rates of flicker and rapid motion.

## Ganglion Cells

It is now known that there are two major groups of **retinal ganglion cells**. One group, which constitutes the majority of retinal ganglion cells, projects their image to certain layers (the parvocellular layers) in the mid-brain (the lateral geniculate nucleus). These ganglion cells are thus called parvocellular or **P-cells**. P-cells tend to be more responsive to high spatial frequencies (fine detail or smaller objects) and low temporal frequencies (steady or constant stimulus presentations and low flicker rates). Various types of P-cells are believed to be responsible for the processing of color vision information, visual acuity and form vision.

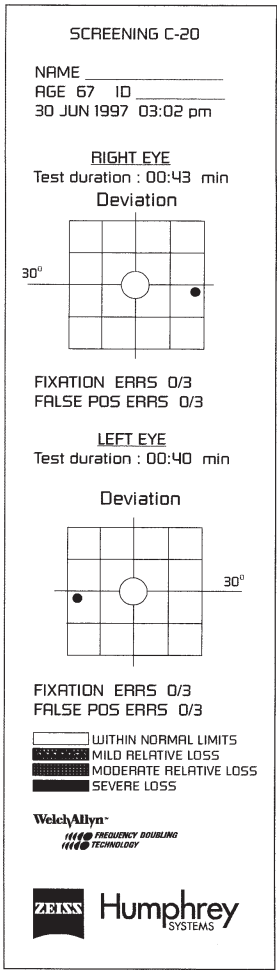


Fig. 7. FDT printout for a normal visual field

The other major group of ganglion cells project their image to neighboring layers (the magnocellular layers) in the mid-brain (again, the lateral geniculate nucleus). These fibers are called magnocellular or **M-cells**. The M-cells constitute approximately 15% of the total number of ganglion cells in the human eye. M-cells tend to be more responsive to low spatial frequencies (broad patterns or larger objects) and high temporal frequencies (high rates of flicker or sudden stimulus changes). Because of this, M-cells are believed to be primarily responsible for the processing of motion and high frequency flicker information.

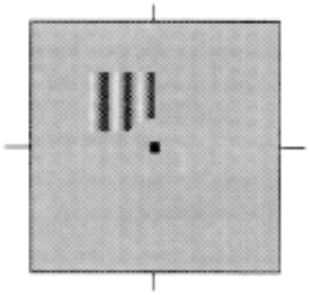

Fig. 6. Spatial frequency doubling affect

The stimulus used in Frequency Doubling Technology is optimally designed for stimulating M-cell nerve fibers. A subgroup of the M-cells has *nonlinear response properties to stimulus contrast,* and it is believed that Frequency Doubling Technology reflects the activity of this subgroup response to contrast. It is felt that evaluating this subgroup of nonlinear M-cells is particularly suited for detecting early damage from glaucoma and other ocular disorders.

The Frequency Doubling Technology stimulus display (Fig. 6) consists of a low spatial frequency grating (broad, fuzzy light and dark stripes) that undergoes rapid counterphase flicker (i.e., light bars become dark and vice versa, with alternations every 20 milliseconds).

When a low spatial frequency grating undergoes high temporal frequency counterphase flicker (I know, it sounds very technical), the stimulus display appears to have twice as many light and dark bars than are actually physically present. Because the frequency of light and dark bars in the stimulus display appears to be twice as high as the actual number of bars, this phenomenon has been called “frequency doubling,” which refers to the appearance of the stimulus display under these conditions (Fig. 6).

Two rapid Flicker Doubling Technology screening tests are available for testing. Each takes approximately 45-90 seconds per eye for the patient to perform the

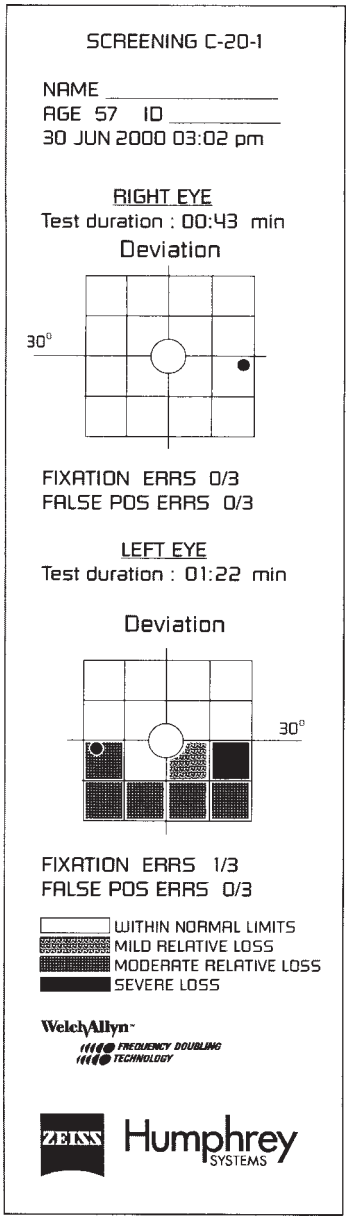


Fig. 8. FDT printout of an abnormal visual field

test. These rapid screening procedures perform well for detection of visual field loss.

You can see an FDT printout from a normal patient in Fig. 7, page 3. Each test field has 17 test boxes, four across for four rows and one centrally. From the printout, you can see that the test tracks false positives (button pressed when there was no stimulus) and false negatives (button not pressed after previously being pressed for the same test spot).

Fig. 8, on the left, shows a printout from the same patient as shown in the abnormal static field printout (Fig. 3) on page two. On the left chart, the upper picture is of the normal right eye. The abnormal lower chart for the left eye shows the significant inferior field loss.

## Types of Tests

The first screening procedure (C-20-1) presents stimuli with a contrast that 99% of the normal population is able to see. The second screening procedure (C-20-5) presents stimuli with a contrast that 95% of the normal population is able to see.

The C-20-1 screening test uses a conservative strategy, while the C-20-5 screening test uses a more liberal approach. The C-20-l screening strategy rarely misclassifies a person with a normal visual field as abnormal, (i.e., it has high specificity). However, the C-20-1 screening strategy sometimes misses very early or subtle deficits because of its high specificity. Sensitivity for detecting moderate and advanced glaucomatous visual field loss is very good, but it is a bit lower for detecting early glaucomatous visual field loss.

Depending on whether sensitivity (detecting early defects) or specificity (correctly classifying persons with normal vision as normal) is of greater importance, either the C-20-5 or the C-20-l screening test can be used, respectively.

There are several other, more extensive, tests available with the Flicker Doubling Technology Instrument. They take four to five minutes per eye and measure the threshold of each portion of the grid. These tests are called Full Threshold tests and are very similar to the static perimetry visual fields seen on pages one and two.

## Other Advantages

Because of the difference in technology and the different type of ganglion cell being tested, the Flicker Doubling Technology Instrument has several advantages over the static perimeter:

(1) decreased room lighting is not necessary (Fig. 9)
(2) fields can be done with dilated eyes
(3) corrections for the patient's prescription are normally not required
(4) the test can also be done with the patient's glasses in place

Fig. 9. Typical setup for FDT testing for a patient

## Cost of This Test

We are happy to offer this test as a part of our regular examinations. We feel that it is important that every patient, who is able, have a screening visual field examination. That can be accomplished effectively with the Flicker Doubling Technology Instrument. It will help us uncover ocular disorders earlier, more predictably, and at less stress for the patient. We will not charge for any screening tests performed with this instrument.

If you have any questions about this instrument, any of our other diagnostic instruments, or any testing procedures that were offer, please call us at (972) 596-3328.