Understanding Visual Fields, Part I; Goldmann Perimetry
Inci Dersu, MD, Michael N. Wiggins, MD, Anne Luther, RN, Richard Harper, MD, and Joseph Chacko, MD

Why is this important?
Visual field testing is a common procedure in almost every eye practice. Whether you are the person performing the visual field or working up a patient who just had a visual field, it is helpful to have background knowledge of this common test. This article is the first of a four-part series designed to review the basic types of fields, how to perform them and the reasoning behind selecting one type of visual field over another.

What are we testing?
A normal patient can see 60 degrees nasally, 110 degrees temporally, 75 degrees inferiorly and 60 degrees superiorly\(^1\). And you might think that all visual fields are designed to measure the total peripheral vision. In fact, most commonly ordered visual fields only test the central portion of a patient's field of vision. The amount of the field tested depends on which test you perform. Only a few tests, such as the Goldmann visual field (GVF), truly evaluate the whole visual field.

Types of Perimetry

Static, Kinetic, Manual or Automated?
There are two basic types of visual field tests commonly used in the clinic. Depending on whether or not the stimulus moves, the test can be classified as static or kinetic. Goldmann perimetry is a common example of kinetic perimetry. The Humphrey Field Analyzer™ (Allergan-Humphrey, San Leandro, CA) is a common example of static perimetry. In fact, both perimeters have the capability of doing both static and kinetic tests, but in practice, they are used as described above.

Perimeters can also be classified as manual or automated, depending on whether the stimulus is moved by hand as in the Goldmann, or if the stimulus location is changed by a computer, as in the Humphrey visual field (HVF).

Terminology: Perimetry is the name of the technique whereas perimeter implies to the machine itself.
Manual Kinetic Visual Fields (i.e. Goldmann Perimetry)

How to perform Goldmann Perimetry
Both the patient and perimetrist affect the accuracy of the GVF. The patient must be able to understand the test, maintain fixation and respond appropriately. The perimetrist must be experienced. It is important to calibrate the stimulus and the background illumination at least once a week to maintain consistency of lighting.

The patient should be comfortably seated. Make all preparations for testing before the patient is positioned in the machine. Lenses used to test the central 30 degrees are determined by the patient’s distance correction and Goldmann’s add for age (Table 1). Use the spherical equivalent whenever the cylinder is 1.00 diopter or less. Myopia, aphakia, pseudophakia or dilation may affect the choice of lens power. People with high myopia or aphakia may require a contact lens for accurate testing. Place the correct lenses in the holder. Insert the perimeter paper and lock into place. Be sure that markings on the paper are aligned with the notches of the frame. Explain the test to the patient. Assess the patient’s ability to push the button on the buzzer in response to the stimuli. Some patients find it easier to respond verbally. Patch the eye that is not being tested: the eye must be completely covered. If there is significant dermatochalasis, tape the excess tissue. If there is ptosis, taping may not elevate the lid sufficiently. In this case, an assistant may be asked to hold the lid during testing of the superior visual field. Move the chin rest to the correct side of the bowl. Help the patient move onto the chinrest and position the forehead against the forehead strap (Figure 1). Emphasize the need to maintain this position during testing. Some machines have a head strap that will help keep the patient in the proper position throughout testing. Turn out the room lights.

Table 1. Adds for GVF perimetry

<table>
<thead>
<tr>
<th>Age years</th>
<th>Add for perimetry</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-40</td>
<td>+1.00</td>
</tr>
<tr>
<td>40-45</td>
<td>+1.50</td>
</tr>
<tr>
<td>45-50</td>
<td>+2.00</td>
</tr>
<tr>
<td>50-55</td>
<td>+2.50</td>
</tr>
<tr>
<td>55-60</td>
<td>+3.00</td>
</tr>
<tr>
<td>60+</td>
<td>+3.25</td>
</tr>
</tbody>
</table>
The perimetrist should adjust his/her seat for comfort. Look at the patient’s eye through the observer’s tube (Figure 2). If the patient’s eye is not centered in the observer’s tube, adjust the vertical and horizontal position of the chinrest with the knobs located below the paper. After this adjustment, ask the patient if he/she is comfortable. Choose the size and intensity of the first target. The most common stimuli are I4e for peripheral and I2e for central visual field. Stimuli of other sizes and intensities may be used to give greater detail to the visual field. A GVF is performed by using the pantograph handle to move the stimuli from the non-seeing area into a seeing area at about 3-5 degrees per second. Start with the peripheral field without the correction. After the peripheral isopter is determined, place the corrective lens into position and proceed with plotting the central field. The blind spot is outlined with the smallest target that easily encompasses it. Static checks to test for scotoma are done after the isopters are completely outlined. To avoid patient fatigue, the test should not exceed 10 minutes per eye. Allow any patient showing signs of fatigue to have rest times during the test.

It is important to evaluate the patient’s ability to do visual field testing. Retesting areas will give you information about the consistency of the patient’s responses. Occasionally, turn off the stimuli and stop testing for a few seconds: the patient should not respond during this time. Watching the patient’s eye through the observation tube while moving the pantograph handle, allows evaluation of fixation. If responses are inconsistent or fixation is poor, reinstruct the patient.
After testing the first eye, allow the patient to sit back and rest while preparations are made for testing the other eye. Look over the completed test to verify all quadrants have been tested sufficiently.

**Figure 2. Recording the results during Goldmann Perimetry**

![Recording the results during Goldmann Perimetry](image)

**Interpreting a Goldmann Visual Field**

The Goldmann Visual field tests the entire visual field, one eye at a time, by plotting points along circles known as isopters (Figure 3). Each isopter should be color-coded to the size and intensity of the stimulus used. The size and intensity of the stimulus can be adjusted. The stimulus size varies between 0 to V, and the intensity varies between 1 and 4 for each 5 dB (decibel) change and further differs between a-e for smaller (1 dB) changes (Table 2). For example, a III 2e stimulus is larger and brighter than a I 2d stimulus, but not as large or as bright as a IV 3a stimulus.
Figure 3. A normal GVF. Note that a dimmer stimulus (I 2e) is used centrally and a brighter stimulus (I 4e) is used peripherally. This GVF is shown with two isopters: one in red and one in blue. The physiologic blind spot is also seen para-centrally as a filled-in blue circle.

Table 2. Options for the stimulus

| Size: 0, I, II, III, IV, V | 0 is the smallest, V is the largest |
| Intensity: 1, 2, 3, 4 | 1 is the dimmest, 4 is the brightest |
| Intensity: a, b, c, d, e | a is the dimmest, e is the brightest |

Terminology: Decibels are a way of comparing the intensity of light to the maximum possible light intensity the machine can produce. It does not have a value that can be measured somewhere other than in the machine, like meters or pounds. 10 dB means the light is 1/10th as bright as the brightest light possible, 20 dB means the light is 1/100th as bright (it is based on log units). So, the higher the number of dB, the dimmer the stimulus. For example, a I 2e stimulus is 5 dB more (or dimmer) than a I 3e stimulus.

Unlike defects on most automated visual fields (which show up as dark areas), most defects on a GVF are changes in the isopter. If the circle has an indented area (see the blue circle in Figure 4 below), this represents an area of the visual field where the stimulus was not seen. Additionally, the distance between the isopters is important. If the defect is mild, the isopter will look indented towards the center, but will remain about the same distance away from the other isopter. However, when the defect is more severe,
the isopters will be much closer together\(^2\). Dense central defects on GVF are generally shaded in, similar to automated tests (Figure 5).

**Advantages and Disadvantages**

During Goldmann perimetry, dimmer stimuli are used for testing the very center of vision with the intensity increasing as more peripheral portions of the field are tested. Some patients might prefer it because there is human interaction. By the same token, it is very much examiner dependent\(^1\). It may not be reproducible by another examiner, and it does not have the advantages of a computerized system for storage and comparison to normative data. Additionally, kinetic perimetry may not be as sensitive as static perimetry in detecting early glaucoma defects\(^3\). However, Goldmann visual fields might reveal scotomas that were missed between the testing points in static perimetry\(^4\). The shape of the defects may also be more impressive in Goldmann perimetry\(^1\). With severe vision loss (vision worse than 20/200), test-retest variability might be better in comparison to automated static testing. In addition, it shows functional (non-organic) defects on visual field testing better than automated testing.

**Indications to use a Goldmann Visual Field**

1. The patient cannot reliably perform an automated visual field. Some patients fall asleep or may become disinterested in participation if left unmonitored during automated testing. Goldmann perimetry cannot be performed without an examiner, so constant patient monitoring is present.

2. The full extent of the visual field needs to be tested. A GVF can be a reliable, reproducible test for the full field and can usually be performed in a short amount of time.

3. A visual field defect found on an automated visual field needs to be confirmed. In routine practice, the automated field is usually just repeated in these cases. However, if the results must be confirmed on the same day as the original automated field and the patient is tired, then a GVF may be appropriate. Additionally, a new visual field defect found on automated testing that also manifests on GVF testing is more likely a true visual field defect than an artifact of the test (Figure 4).
Specific Uses of Goldmann Visual Fields

Low Vision
Goldmann visual field testing is preferred over automated visual field testing for low vision patients with central scotomata for the following reasons: 1) fixation is easier to monitor when a human perimetrist is performing the test since they can provide direction and encouragement to the patient and 2) also due to difficulties with fixation, a human perimetrist is better able to map the size and shape of the central scotoma. The size and shape of the central scotoma can be helpful in guiding the patient and therapist during eccentric viewing training in locating a preferred retinal locus. Other less common indications would include patients with isolated peripheral islands of remaining visual field and patients who are unable to provide reliable automated visual field responses.
Figure 5. Note the large central scotoma in this patient with low vision.

**Neuro-Ophthalmology**

Goldmann visual fields (GVF) are essential to the practice of Neuro-Ophthalmology. In fact, ophthalmic techs with training in GVF's are widely sought-after. First of all, the GVF is used when patients are unable to perform a Humphrey visual field (HVF). This may be due to fatigue, slower cognitive skills, low reliability, poor fixation, or decreased vision. Secondly, the GVF is helpful when the visual defect is located or extends beyond the central 30 degrees (peripheral visual field defect). Lastly, the GVF is extremely useful in patients with functional visual loss. These patients have no organic basis for their decreased vision. They run the gamut from malingerers (to feign for gain) to the psychologically depressed (subconscious loss of vision). Certain visual field defects are indicative of functional patients. These include spiraling isopters (Figure 6), crossing of isopters, and severely constricted fields (Figure 7).
Figure 6. Spiraling of Isopters. Note both isopters constrict as the test progresses.

Figure 7. Constricted Visual Fields OU which improve to normal one month later with reassurance that no organic lesion exists.
Summary

Goldmann visual field testing is an invaluable test to detect and follow the progression of scotomas in a variety of ocular diseases, especially when performed by an experienced tester. However, the ease and other advantages of using computerized systems has relegated GVFs to mostly a second choice test. Although older, it still has value in our clinics and should be understood by all ophthalmic personnel. Its newer sibling, automated perimetry, will be visited in part II of our four part series on understanding visual fields.

This work was supported in part by an unrestricted grant from Research to Prevent Blindness and the Pat & Willard Walker Eye Research Center, Jones Eye Institute, University of Arkansas for Medical Sciences (Little Rock, AR).

References


