A thorough eye examination (including gonioscopy with a Goldmann or Zeiss goniolens) is a prerequisite prior to undergoing specific tests for glaucoma. In Glaucoma management serial tests over several years have more value than a single one time test. Therefore it is important that same type of test is repeated many times over a period of several years. The reason why this is so is that we are trying to ascertain whether a given target pressure has indeed stopped further damage. This determination is only possible if we have examinations from previous years to compare against and it can be shown that there are no new findings or worsening. Therefore, one must maintain good long-term records and if you change physicians for any reason, it is important that you have all prior records forwarded to the current physician.

The 'Gold standard' tests are determination of eye pressure with an applanation tonometer at least 3 to 4 times a year and stereoscopic optic nerve pictures and visual field tests every year. The newer tests are useful in making the diagnosis of Glaucoma at an earlier stage and are also useful to determine progression of damage at an earlier stage than the traditional tests, at least in theory. As more data becomes available the promised potential of these tests may be realized.

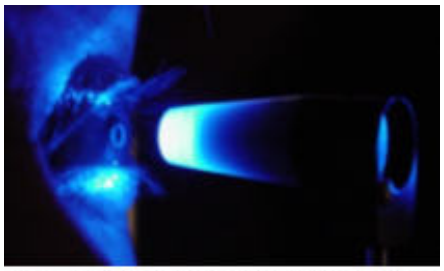
The Established 'Gold Standard' tests

- Intraocular Pressure Measurement
- Visual Field Test
- Stereoscopic optic nerve photographs

The Newer tests

- Nerve Fiber Layer analyzers
  - GDx
  - Optical coherence tomography (OCT)
  - Heidelberg tomograph
- Ocular Blood Flow Measurement
- Ultrabiomicroscopy (UBM)

Intraocular Pressure Measurement


Goldmann Applanation Tonometry

The current standard is to use a Goldmann applanation tonometer to determine the intraocular pressure. The device is mounted on the slit lamp. An anesthetic drop and a dye (fluorescein) is placed in the eye and the gonioprism is made to gently contact the cornea. The physician sees green rings through the gonioprisms and when the half rings overlap (the 'endpoint'), the eye pressure reading in mmHg is recorded.

Other means to record the intraocular pressure is to use different types of tonometers. These are the air puff tonometer, Perkins tonometer, Pneumotonometer and Schiotz tonometer. Proview is an instrument that allows estimation of eye pressure at home.

Visual Field Test

In Glaucoma the field of vision is the first to be affected. By the time the central vision is affected, glaucoma is already far advanced with almost all peripheral vision permanently lost. That is why glaucoma is called the 'sneak thief of vision'. When we test vision on an eye-chart, only the

central vision gets tested. So reading 20/20 on the eye-chart would mean you have great central vision, but no comments can be made about the peripheral field of vision.

Automated (computerized) field analyzers, such as the Humphrey or the Octopus perimeters are used to perform the field of vision test. A light point is presented in a predetermined fashion (location sequence) in a lighted bowl and the patient is asked to press a button when they see the light point. The responses are analyzed statistically and compared with a database of normal responses.

Any deviations from normal are marked on a printout as black squares which represent visual field-defect areas.

In designated areas on the printout, you will find the following:

- Reliability Indices
- Glaucoma hemifield test (GHT)
- Global Indices

These are all very important indices and are used to answer the most important question one has i.e. **is the visual field abnormal?** The Ocular Hypertension Treatment Study (OHTS) criterias that define an abnormal visual field are useful and make it easier to answer this difficult question. There is no established 'gold standard' for defining an abnormal visual field, and even the criteria in different NIH supported glaucoma clinical trials have varied. The OHTS criteria are highly specific - meaning that it is extremely unlikely that a normal field will be wrongly labeled as abnormal using these criteria (*Invest Ophthalmol Vis Sci.* 2002;43:2660-5). However, to ensure that the field defect is not the result of a random fluctuation, the newly detected visual field abnormality must be confirmed by repeating the field test.

Although this discussion has been limited to Humphery perimeter as that is the most likely to be used in the US, there is a different type of perimeter -Goldmann perimeter- which is now rarely used in clinical practice except in special circumstances such as in patients with limited cooperation or poor vision. Depending upon the size of the test stimulus, a goldmann plot maps out the outer margins of the visual field (isopters). Current visual field criteria that define legal blindness in the US are based on Goldmann perimetry. If an individual had complete peripheral visual field loss and normal vision within the central 20° diameter (the current visual field definition of legal blindness), this would correspond to a 'Mean Deviation (MD)' of approximately 22 dB on Humphrey visual field test. Therefore 'MD' worse than 22 dB can be considered to represent a level consistent with legal blindness.

It does take some getting used to the visual field test before a meaningful output is generated (it may take up to 3 field tests). This learning effect is a well recognized phenomenon. After a reliable initial baseline is established, further field tests are performed periodically (usually every year) to detect any new field defects or to detect worsening of computer generated indices (especially CPSD). This answers the second important question one has i.e. **is the visual field worsening?** It is indeed a challenge to determine how to quantify worsening of field defects. Although computerized analysis are available, perhaps the most common universally practiced method is to visually compare a sequence of reliable field tests taken over several months or years and to look for changes in the visual field defect pattern. Before modifying the treatment regimen, the field defects are usually confirmed on a repeat field test.

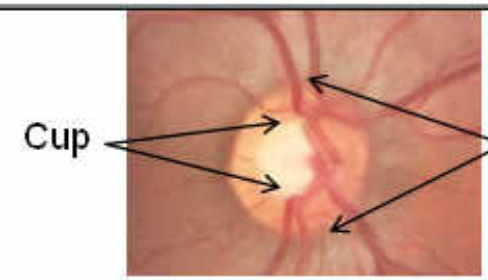
Visual field testing is just one of many methods used to diagnose and follow glaucoma progression and has meaning only when used in concert with other tests such as intraocular pressure measurements, optic nerve examination and other newer tests. To highlight an important limitation of the field test consider this - It is possible to lose up to 50% of your optic nerve fibers without any field defects showing up on visual field testing. Recently several newer strategies have been introduced which allow for earlier detection of field defects (blue yellow perimetry).

Blue-yellow perimetry, also known as Short Wavelength Automated Perimetry (SWAP), represents a recent advance in the early identification of glaucomatous visual field loss. It differs from standard automated perimetry only in that blue light is used as the stimulus, and yellow light is used for the background illumination. SITA, which stands for Swedish Interactive Thresholding Algorithm, uses a software program to reduce the length of a visual field test while enhancing sensitivity and specificity. SITA is used in Humphery Field Analyzer.

Optic Nerve Pictures

A good method to detect glaucoma progression is to study changes in the optic nerve features (disc cupping, vessel baring) over time. Most physicians record the cup to disc ratio as a fraction (e.g. 0.5 cup to disc ratio means approximately 50% cupped disc) and also draw a rough sketch of the optic nerve in the patient chart. Such documentation is unlikely to detect small (but clinically relevant) changes that may potentially necessitate therapy review.

Optic nerve photographs are usually requested every year and comparing photographs of optic nerve taken over the course of several years is without question a very effective method to follow glaucoma progression.



C:D of 0.5 means than the Cup to Disc ratio is 0.5 i.e. cupping is about 50% of total disc area. The 'orange/pink' rim of disc contains nerve fibers. The 'white' cup is a pit with no nerve fibers. As glaucoma advances, the cup (white pit) occupies most of the disc area.

The Newer Tests

The visual field test depends upon patient responses i.e. it is a subjective test. It tests vision i.e. the function of the nerve fibers. The new tests (nerve fiber analyzers) adopt a different objective strategy that is not dependent on patient responses. These tests, by one way or the other, measure the physical thickness of the nerve fibers in the retina. Since in glaucoma the nerve fibers are lost, patients with glaucoma are likely to have thinner nerve fiber layer than normal. By measuring changes in nerve fiber layer thickness over time these tests can detect glaucoma progression. The validity of these tests have been established in many peer reviewed reports. Perhaps these tests will become the 'gold standards' in the future as more experience is gained with these tests and as they become more widely available, however at present they are best considered supplemental tests. Going by the logic that 'more information is better than less' a resonable argument can be made to get these tests (in addition to the traditional tests) even if their role in glaucoma management is debatable.

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