Retinal Nerve Fiber Analysis: the Role It Plays in Assessing Glaucoma
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Every day, patients experiencing visual difficulties are seen in the optometric practice. This can range from a myopic patient in her early teens, experiencing vision changes as she continues to grow and mature, to a patient who has suffered an injury on the job. As the practice ages, so do the patients. With increasing age, visual conditions may develop that are associated with aging. One such condition that threatens patients’ vision is a disease known as “glaucoma.”

Glaucoma is an eye disorder in which intraocular pressure is too high for the health of the eye. A backup of fluid in the eye, called “aqueous humor,” causes an increase in pressure. The aqueous humor circulating in the anterior chamber does not drain properly, causing the optic disk to become cupped, which will eventually cause damage to the optic nerve.(1) The optic nerve is made up of many fibers and increased pressure inside the eye (intraocular pressure) can cause damage to the fibers. Total blindness can occur if the entire nerve is destroyed.(2) Cupping of the optic nerve head and high intraocular pressure are often used to determine a patient is experiencing the development of glaucoma. Evaluating the retinal nerve fiber layer also aids in making the diagnosis. In order to see, retinal fibers convey the visual message using retinal ganglion cells that emanate from the eye and transmit the visual world through the optic nerve of the brain.(3) Loss of vision in someone with glaucoma is a result of degeneration of retinal fibers that comprise the optic nerve. This nerve is made up of over one million nerve cells. As pressure builds up, the nerve can become compressed, which will damage the nerve cells and they will eventually die. In addition to optic nerve damage, the visual field will develop nerve fiber bundle defects, and eventually there is a loss of visual field.

Glaucoma is the leading cause of blindness in the world. It affects approximately 67 million people worldwide.(2) Unfortunately there are no symptoms, until the disease has done permanent damage. Therefore, patients who delay testing until they experience symptoms are putting themselves at risk. Glaucoma is more prevalent among patients over 50 years old, African Americans, and those who have a family history for development of glaucoma.(2) The number of patients with glaucoma is expected to increase, due to the fact that people are living longer. There is no cure at this time and the damage done is irreversible. Research is currently being conducted to determine if stem cells can be manipulated to improve the repair process of ocular fibers to slow down progression of the disease. A partnership between Glaucoma Research Foundation and the Kirsch Foundation, Catalyst For a Cure (CFC), has researchers working to identify new genes that are uniquely found in retinal ganglion cells, which progressively die in glaucoma patients.(4) These genes would act like an address to deliver treatments directly to dying retinal ganglion cells found in glaucoma. This may lead to therapies that will slow or reverse the progression of the disease. Regardless, the key to helping patients with glaucoma is early diagnosis. The sooner they are diagnosed and treated, the slower it progresses and blindness can possibly be prevented.
In order to diagnosis glaucoma, optometrists and ophthalmologists usually test intraocular pressure (IOP), the optic nerve head, and visual function. These tests are helpful because the IOP provides pressure readings patients may experience over a period of time and how stable that pressure is. Pressure measurements are tested using an instrument called a Goldman tonometer. The goal of treatment is to lower and maintain the lower pressures. The target number depends on the health of the nerve, the visual field analysis, and the retinal fiber layer. Therefore, patients with normal pressure readings of 11 or 12 may have glaucoma and patients with pressure readings of 24 may not have the disease.

Recent research has found that corneal thickness can affect pressures obtained. Use of pachymeters to determine corneal thickness has become a standard of care in most optometric offices. Patients with thicker corneas will register higher pressure. On the other hand, those patients with thinner corneas will exhibit lower pressures. Someone with extremely thin corneas can exhibit pressures that are actually as much as seven points higher than what is measured with a tonometer.

The appearance of the optic nerve head provides information about damage that has occurred or the potential threat of damage. An opthalmoscope allows the doctor to see the optic disk so that he or she can determine any changes to the disk. These changes are known as cupping. The information gathered by opthalmoscopy allows the optometrist to evaluate the optic nerve and grade its health by noting the cup-to-disk ratio. This is a comparison of the cup (depressed area of the nerve) to the entire diameter of the optic nerve. As the development of glaucoma increases, the depression increases.

Visual field tests screen for visual field defects. The visual field is the area a person sees, including central and peripheral areas. Eye structure, as well as the visual pathway linking the eye to the brain, determines a patient’s visual field. Visual field testing assesses a patient’s visual function (how well they see) while mapping a patient’s field of vision. Testing shows how different intensities of light are seen, or not seen, in the field of vision and if there are blind spots developing as a result of glaucoma, other eye pathologies, or neurological problems. Automated visual field screeners, such as the Humphrey, help determine how patients respond to light stimuli and notes if and where the defects are located.

These tests give much useful information in managing glaucoma cases; however, one recent test that analyzes the retinal nerve fiber layer has become important in the assessment, diagnosis, and management of glaucoma. By studying the retinal nerve fiber layer, as opposed to only the nerve head, damage can be detected sooner. Retinal fiber layer changes will occur before visual field loss or optic disk damage. Earlier diagnosis allows the optometrist to start treatment sooner, which can slow the progression of glaucoma. It also allows the doctor to monitor the disease more effectively. Visual field screeners also incorporate programs to analyze progression over time, which allows the optometrist to alter treatment, if it is determined that the current treatment is not giving expected results. Additionally, the screener produces more reliable data because it is an objective test, as opposed to a subjective test. Another advantage is that the tests can be reproduced, as opposed to the visual field, (a subjective test), which can vary depending on the patient’s attentiveness and alertness on a particular day. The objective approach is becoming more popular and commonly
used as its validity is proven. It is becoming highly recommended that retinal nerve fiber analysis be used as part of a glaucoma exam.

The development of glaucoma results in loss of nerve tissue; the ganglion cells in this tissue are retinal cells that are the third or last neurons in the vertical linkage of the retina and are similar to the relays in the spinal cord and brain stem. A ganglion is an encapsulated neural structure consisting of a collection of cells bodies in neurons, a mass of nerve cells. It has been found that monitoring the nerve fiber layer is critical to managing glaucoma.(3) Assessment of cupping is only a part of optic disk evaluation when diagnosing glaucoma. Other features of the optic nerve head and retinal fiber layer must be evaluated, especially in borderline cases.

In summary, both structural and functional aspects need to be evaluated in order to properly diagnosis glaucoma.(9) Since some of these tests are subjective, it is also important to incorporate the retinal nerve fiber layer evaluations, because if has been found that this objective test gives more reliable information. Other advantages include that dilation is not necessary and results are obtained quickly, within 5 to 10 minutes. The shorter testing time is more pleasant for patients and helps keep them more at ease. There is rarely the issue of patient inattentiveness due to the minimal time involved, as compared to conducting visual field testing. It is user friendly, does not take up a lot of office space, (as it fits on a tabletop), and within a half hour, a paraoptometric can be trained and become familiar with the analyzer. Retinal nerve fiber layer analysis is proving to have a significant function in assessing, managing, and treating glaucoma. Treatment for patients may occur sooner, or results may show that it is not needed at this time, since retinal nerve fiber layer analysis gives the doctor more complete information.

Finally, stem cell research of the development of glaucoma is in its infancy, but researchers are hopeful that someday there will be a way to stop glaucoma from developing and that those with visual field loss can be treated to reverse such damage. Meanwhile, it is important that doctors use the latest technology available to keep their patients’ vision healthy.

References

1. Glaucoma Foundation. At URL: www.glaucomafoundation.org/education (last accessed 2/16/05).
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Select the option that best answers the question.

1. All but one of the following are considered when diagnosing the development of glaucoma.
   a. intraocular pressure
   b. optic disk ratio
   c. visual field analysis
   d. refraction

2. A normal intraocular measurement is:
   a. 60 mm-hg
   b. 30 mm-hg
   c. 25 mm-hg
   d. 14 mm-hg

3. There are no risk factors for development of glaucoma.
   a. true
   b. false
4. It takes ________ minutes to perform a retinal fiber analysis.
   a. 3-5
   b. 5-10
   c. 15-20
   d. 30-35

5. A paraoptometric can be trained to use retinal nerve fiber analyzer in:
   a. 5 minutes
   b. 30 minutes
   c. 2 hours
   d. 3 days

6. The results of the retinal nerve fiber analysis are available:
   a. immediately
   b. within 45 minutes
   c. in one hour
   d. one week after the test

7. The retinal nerve fiber analysis is an:
   a. objective test
   b. subjective test
   c. Goldman test
   d. none of the above

8. A visual field analysis detects nerve loss sooner than retinal nerve fiber analysis.
   a. true
   b. false

9. The cure for glaucoma is:
   a. a corneal transplant
   b. intense doses of medication
   c. surgery
   d. there is no cure

10. Defects in the retinal fiber layer occur__________ visual field loss.
    a. at the same time as
    b. before
    c. after
    d. b and c