The Nuts and Bolts of Detecting Glaucoma
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Glaucoma is an asymptomatic disease early in the process until it has affected much of a patient’s visual field. Unfortunately, this may be part of the reason why 50 percent of those with glaucoma don’t know they have it. As such, compliance with treatment is often a difficult task because of the asymptomatic nature of the disease early on. We will discuss the detection of glaucoma, along with some risk factors for the development of the disease.

Defining Glaucoma

Glaucoma is a group of diseases of the optic nerve involving loss of retinal ganglion cells in a characteristic pattern of optic neuropathy. Although raised intraocular pressure is a significant risk factor for developing glaucoma, there is no set threshold for intraocular pressure (IOP) that causes glaucoma. In addition to increased intraocular pressures, there are a number of other risk factors that can lead to the development of glaucoma including: family history, abnormalities in corneal thickness and the appearance of an unhealthy optic nerve head. In addition to examining these factors, visual field testing and optic nerve head imaging will help in assessing whether a patient has glaucoma. In this article, we will look at many of these factors and their role in detecting glaucoma.

Intraocular pressure

Intraocular pressure is one of the major risk factors for the development of glaucoma. As IOP increases in the eye, the optic nerve is more likely to be damaged. A number of studies have shown that patients who have high IOP’s are more likely to develop glaucoma or increase the severity of their glaucoma. However, it is important to realize that just because someone has high IOP’s does not necessarily mean that they will definitely develop glaucoma.

Traditional wisdom has told us that patients with IOP’s above 21 mmHg have pressures that are above the normal range, and those that have IOP’s below 21 are within the normal range. Certain patients will have IOP’s that are greater than 21 mmHg, but will not develop glaucoma. These patients are referred to as having ocular hypertension. Inversely, some patients may have IOP’s that are below 21 mmHg, but still go on to develop glaucoma. These patients are referred to as having normal tension glaucoma. It is important to understand that IOP is only one risk
factor for the development of glaucoma, and it needs to be evaluated with a number of other clinical factors to determine whether someone has glaucoma.

**Corneal thickness**

Since the publication of the Ocular Hypertension Treatment Study in 2002, eye care practitioners have embraced measuring corneal thickness for those who are at risk of developing glaucoma and those who are currently being treated for glaucoma. In this study, it was found that patients with central corneal thickness of less than 556 micrometers had the highest risk of developing glaucoma and those patients with central corneal thickness greater than 588 micrometers had the lowest risk of developing glaucoma\(^2\). Central corneal thickness is thus an important factor to consider for those being monitored in our offices as glaucoma suspects.

**Optic Nerve Head Assessment**

Assessment of the optic nerve head is one of the most important things that a practitioner does during the examination of a glaucoma suspect. The optic nerve has a number of important features that should be examined on every patient. These are the cup, the rim, and the region outside the optic nerve head\(^4\).

The cup is the center portion of the optic nerve head. It is a small excavation in the optic nerve head. There are a number of normal variations in its appearance. The cup is estimated as the percentage of the nerve head that it occupies both horizontally and vertically. It is usually recorded as a decimal value. So, for example, if the vertical dimension of the cup is 60 percent of the vertical dimension of the optic nerve head and 50 percent of the horizontal dimension, it would be recorded as 0.60 V/0.5H (Figure 1). In general, the larger the cup, the greater the risk of a patient having or developing glaucoma\(^2\).

The rim tissue of the optic nerve is extremely important to assess as well. The rim tissue of the optic nerve head is the light pink tissue that surrounds the cup. The most important factor to consider when assessing the rim is whether or not there is any thinning in any of the regions. Most healthy optic nerve head rim tissue follows the ISNT rule. ISNT is an acronym for: Inferior, superior, nasal, and temporal. The rim tissue is usually the thickest inferiorly, then superior, then nasally and then temporally. Figure 2 demonstrates a healthy optic nerve head. If this ratio is not followed, and there is significant thinning of the rim tissue in any of these regions, the patient may have glaucomatous damage. Figure 3 demonstrates an optic nerve where the ISNT rule is
not followed, and the patient has glaucomatous damage of the optic nerve.

In addition to assessing the rim tissue for thinning, it is important to examine the optic nerve for the presence of any hemorrhages. The presence of a hemorrhage on the rim tissue or within 1 disc diameter of the optic nerve usually indicates progression into glaucoma or a worsening of the disease. Figure 4 shows an optic nerve head hemorrhage.

Optic Nerve Head Imaging

Some of the greatest advancements in the field of glaucoma detection and management have been in the field of optic nerve head imaging. The goal of optic nerve head imaging is to track microscopic changes in the structure of the optic nerve, to assist in determining whether treatment needs to be started or changed. Three technologies that have revolutionized the way we view the optic nerve are: (1) Scanning Laser polarimetry, (2) Confocal scanning ophthalmoscopy and (3) optical coherence tomography.

(1) Scanning Laser Polarimetry

Scanning laser polarimetry is based on the principle that polarized light changes as it passes through the retinal nerve fiber layer. The nerve fiber layer is located around the optic nerve head. The nerve fiber layer decreases in thickness as the optic nerve is damaged from glaucoma. With this technology, we can see changes over time to the nerve fiber layer, and thus determine whether someone is converting to glaucoma.

Scanning laser polarimetry is commercially available as the GDx. This technology is widely utilized to diagnose and monitor glaucoma patients over time. Figure 5 shows an example of a GDx printout. The left side of the printout shows the results from the right eye and the right side of the printout shows the left eye results. The nerve fiber layer thickness is shown at the bottom of the printout. As you can see on either side, there is a thick green and pink band. This represents the normal range of thickness for both the right and the left eye. The dark line represents the patient's measurements. As you can see from the figure, it is easy to determine whether the patient's nerve fiber layer thickness is in the normal range.

(2) Confocal Scanning Ophthalmoscopy
Confocal scanning ophthalmoscopy is technology that is commercially available as HRT. This instrument measures the topography of the rim tissue and cup of the optic nerve, and compares it to a normative database to determine whether the measurements are in the normal range. It informs the clinician whether or not the regions are within the normal range by designating a green check mark if it is within the normal range, a yellow exclamation mark if it is borderline and a red “x” if the area of the optic nerve falls outside of the normal range. The software also allows measurements over time to be tracked for changes as well. An example of a printout from an HRT is shown in figure 6.

(3) Optical Coherence Tomography

Optical coherence tomography (OCT) has gone through significant advancements over the last several years. The newest generation OCT acquires more detailed images in less time. This makes using the equipment more efficient, and the information gathered more accurate.

With OCT technology, a cross-section image of tissue can be generated. This is of significant value when examining the macula. Additionally, this technology has a significant role in glaucoma detection and management. It measures the retinal nerve fiber layer thickness around the optic nerve. Just like the other two technologies, it provides a normative database and compares the patient’s measurements to the normal range. Figure 7 shows an example of an OCT. The nerve fiber layer thickness is shown on the left side of the printout.

The normal range is shown in green, borderline in yellow, and red is below the normal range. The patient’s readings are seen as the solid black line. The colors that the line passes through will determine if those portions of the nerve fiber layer are within or outside the normal range.

Visual Field

Visual field measures the function of the optic nerve. It allows the clinician to assess whether damage that has occurred to the optic nerve has affected the visual field measurements. Performing visual fields regularly for patients who are glaucoma suspects is important so that the determination can be made if visual field changes from early glaucoma are occurring.
One of the most important things with visual field testing is to attain results that are as accurate as possible. The best way to do that is to make sure that the patient stays focused on the fixation target. Make sure that you communicate the accuracy benefits of continuously looking at the fixation target, so that the patient knows how important it is and can make their best attempt to do so.

Visual field defects from glaucoma can occur anywhere in the visual field, but most likely initially occur in the nasal region of the visual field. This area is important to assess for changes. Many clinicians will have patients repeat visual field testing if they show a defect, to determine whether the defect is present after repeat testing. If the test is run again and the defect is still present, it is likely a true defect. But, if the visual field is tested and the defect is not present the second time the test is taken, it may not truly be there. Visual fields play an integral role in detecting glaucoma and determining if and when to begin treatment.

Summary

Glaucoma continues to be a challenging disease to detect and treat. Significant advancements in diagnostic technologies and research have provided a number of useful clinical tools. With a better understanding of these technologies and how they can help in the diagnosis of glaucoma, paraoptometrics are better armed for patient care in today’s modern practice.

References

1) http://en.wikipedia.org/wiki/Glaucoma
2) Gordon MO, et al. The Ocular Hypertension Treatment Study: a randomized trial determines that topical ocular hypotensive medication delays or prevents the onset of primary open-angle glaucoma. Arch Ophthalmol. 2002 Jun;120(6):701-13
4) Fingeret M et al. Five rules to evaluate the optic disc and retinal nerve fiber layer for glaucoma. Optometry 2005; 76: 661-668.
The Nuts and Bolts of Detecting Glaucoma Questions

You must be an AOA Associate member, and answer seven of ten questions successfully to receive one hour of continuing education credit. This quiz is comprised of multiple-choice questions designed to test your level of understanding of the material covered in the continuing education article, “The Nuts and Bolts of Detecting Glaucoma”.

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Select the option that best answers the question.

1) Which of the following is not a risk factor for the development of glaucoma:
   a. Increased IOP
   b. Family history
   c. Appearance of the optic nerve
   d. Cataracts

2) Someone is considered to have ocular hypertension if they do not have glaucoma and their IOP is greater than:
   a. 12
   b. 21
   c. 16
   d. 20

3) Someone is considered to have normal tension glaucoma if they have glaucoma and their pressure is less than:
   a. 12
   b. 21
   c. 26
   d. 31
4) In the ocular hypertension treatment study, what group of patients was most likely to develop glaucoma?
   a. Those with central corneal thickness greater than 588
   b. Those with central corneal thickness greater than 556
   c. Those with central corneal thickness less than 556
   d. Those with central corneal thickness less than 588

5) In the ocular hypertension treatment study, what group of patients was least likely to develop glaucoma?
   a. Those with central corneal thickness greater than 588
   b. Those with central corneal thickness greater than 556
   c. Those with central corneal thickness less than 556
   d. Those with central corneal thickness less than 588

6) Scanning laser polarimetry technology is commercially available as:
   a. GDx
   b. HRT
   c. OCT
   d. CC

7) Confocal scanning ophthalmoscopy is commercially available as:
   a. OCT
   b. HRT
   c. GDx
   d. CCT

8) What does OCT technology measure that is valuable when monitoring glaucoma suspects?
   a. Visual field
   b. Retinal nerve fiber layer
   c. The rods and cones
   d. Cataract

9) Visual field measures the function of the:
   a. Lens
   b. Cornea
   c. Meibomian glands
   d. Optic nerve

10) Visual field defects from glaucoma can occur anywhere in the visual field but most likely initially occur in the _____________ region of the visual field.
    a. Nasal
    b. Temporal
    c. Superior
    d. Inferior