Advances in Ophthalmology and Optometry 2 (2017) 243–260

ADVANCES IN OPHTHALMOLOGY AND OPTOMETRY

The Use of Optic Disc and Retinal Nerve Fiber Imaging in Detecting Structural Damage Before the Onset of Functional Loss

Edward Stephen Yung, MD[a,*], Eileen Linda Chang, MD[b], Marlene R. Moster, MD[a]

[a]Department of Glaucoma, Wills Eye Hospital, Thomas Jefferson University School of Medicine, 840 Walnut Street, Suite 1110, Philadelphia, PA 19107, USA; [b]Department of Ophthalmology, Nassau University Medical Center, 2201 Hempstead Turnpike, East Meadow, NY 11554, USA

Keywords

• Glaucoma • Imaging • Optic nerve • Photography
• Confocal scanning laser ophthalmoscopy • Scanning laser polarimetry
• Optical coherence tomography • OCT angiography

Key points

- Optic nerve head and retinal nerve fiber layer imaging objectively documents characteristic glaucomatous findings and is used adjunctively alongside visual field monitoring to diagnose and monitor for glaucomatous progression.
- Optic disc stereo photography remains a common imaging modality independent of changes in technology, although it is subject to variation in interpretation.
- Although optical coherence tomography is the most commonly used modality to quantitatively monitor for changes in retinal nerve fiber layer thickness, several limitations persist limiting its role in disease management.
- Quantitative retinal nerve fiber layer thickness values obtained with confocal scanning laser ophthalmoscopy, scanning laser polarimetry, and optical coherence tomography are not interchangeable with each other.
- Newer technology has been developed to image the optic nerve, although additional long-term studies are needed to assess their use in the management of glaucoma.

Disclosure Statement: The authors have nothing to disclose.

*Corresponding author. *E-mail address:* cal.edyung@gmail.com

http://dx.doi.org/10.1016/j.yaoo.2017.03.011

INTRODUCTION

Glaucoma is an optic neuropathy affecting retinal ganglion cells (RGCs) and their axons, leading to progressive thinning of the retinal nerve fiber layer (RNFL). Although optic nerves from healthy individuals have been shown to lose ganglion cells at a rate of approximately 5000 axons per year [1], this loss is accelerated in glaucoma. These changes are often initially detected on clinical examination, revealing characteristic diffuse or focal rim thinning of the optic nerve head (ONH).

Loss of RGCs in glaucoma leads to progressive visual field defects, routinely monitored using automated perimetry. This method of visual field testing, among others, requires the patient to relay information about the presence or absence of vision. Thus, automated perimetry can be quite subjective and dependent on patient reliability, opening the possibility for significant intertest variability. It has also been shown that significant RGC loss and structural RNFL defects precede the onset of characteristic glaucomatous visual field defects [2]. By the time a 5-dB decrease in sensitivity has been detected on visual field testing, 20% of RGCs would have been lost [3].

Assessment of structural damage in the optic nerve is a more objective method for detecting glaucomatous progression and can demonstrate damage before the onset of visual field defects. Direct ophthalmoscopy or slit-lamp indirect ophthalmoscopy with a secondary handheld lens was the initial gold standard used to assess the structure of the optic nerve. Significant variation, however, exists in the anatomy of normal optic nerves, with histology studies finding a wide range in the number of axons found in normal eyes [1]. This often makes the diagnosis of early glaucomatous optic neuropathy difficult on clinical examination.

Permanent records of optic nerve appearance were initially limited to optic nerve drawings and estimations of vertical cup-to-disk ratio, leading to significant variability even among experts. Evaluation of cup-to-disc ratio has also been shown to be poorly predictive of future glaucomatous visual field damage [4]. Focal wedge-shaped RNFL defects, best visualized using the red-free filter at the slit lamp, is another indicator of glaucomatous structural damage. This finding, however, is difficult to objectively document without imaging and occurs less commonly than diffuse RNFL loss.

Ophthalmic imaging modalities yield objective, permanent documentation of characteristic optic nerve findings and RNFL defects. This article reviews the clinical performance and limitations of the various imaging modalities.

SIGNIFICANCE

Stereoscopic optic disc photography

Optic disc stereophotography was the first technique introduced to objectively document optic nerve appearance. Color photographs allow providers to monitor progression in optic disc cupping, as well as the development of other pathognomonic patterns such as rim notching and acquired optic nerve pits. Red-free filters applied to fundus cameras allows for qualitative documentation of focal RNFL thinning, although diffuse thinning is difficult to detect.