The Importance of Optic Disc Photography

Optic disc photography still has a role in glaucoma management despite technological advances in optic nerve head imaging.

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The examination, evaluation, and documentation of the optic disc and retinal nerve fiber layer (RNFL) are essential to the diagnosis and monitoring of glaucoma. Although IOP readings and visual fields are helpful, clinicians cannot use them alone to accurately predict which patients have glaucoma or which patients’ disease is progressing. Optic disc stereophotography has traditionally been the gold standard for the documentation of the optic nerve head’s appearance. In the past 2 decades, the development of image-analyzing technology has offered a quantitative assessment of the optic nerve’s structure. Clinicians are now left to ponder whether optic disc photography still has a role in the management of glaucoma.

LIMITATIONS OF IOP AND VISUAL FIELDS

In the Baltimore Eye Survey, more than half of all patients with glaucoma had a screening IOP of less than 21 mm Hg.1 In the Ocular Hypertension Treatment Study (OHTS), fewer than 10% of patients with elevated IOP progressed to glaucoma in 5 years, and the first detectable glaucomatous changes occurred in the optic disc, prior to changes in the visual field, in 50% of individuals.2 Optic disc progression was determined by masked observers evaluating serial stereoscopic disc photographs in the OHTS.

Visual field examinations are subjective, and interpretation tends to be complicated by short- and long-term fluctuations.3 Potentially significant visual field changes often need to be matched with the appearance of the optic nerve and nerve fiber layer in order to differentiate true progression from fluctuation. The disc changes that occur in patients with glaucoma, however, tend to be characteristic of glaucoma and are highly useful in its diagnosis and monitoring.

CLINICAL EVALUATION OF THE OPTIC DISC

A clinician can identify subtle structural changes consistent with progression using indirect stereoscopic slit-lamp biomicroscopy. Clinical features important to the evaluation of the optic nerve head for glaucoma include narrowing of the neuroretinal rim’s width, asymmetry in disc cupping, optic disc hemorrhage, the presence of beta zone peripapillary atrophy, and a loss of peripapillary RNFL.4 The normal optic disc’s neuroretinal rim is characteristically broadest inferiorly, followed by the superior and nasal rims, and narrowest temporally (the ISNT rule). This relationship was first reported by Jonas et al, who found that a relatively narrow rim inferior to temporal or superior to temporal can indicate glaucomatous damage.5

An analysis of patients from the OHTS and the European Glaucoma Prevention Study showed that an ocular hypertensive patient’s risk of developing glaucoma increased almost 50% for every 0.1 difference between eyes in cup-to-disc ratio.6 In studying normal-tension glaucoma, Drance et al found an increased risk of glaucomatous progression with the presence of a disc hemorrhage (Figure 1).7 A patient with normal-tension glaucoma and a disc hemorrhage was found to be 2.72 times as likely to have progressive disease compared with a patient who does not have this finding. Later studies showed that disc hemorrhages tend to occur within the region of widest peripapillary atrophy and that both disc hemorrhages and peripapillary atrophy tend to occur at areas of damage to the neuroretinal rim.8,9

Clinicians commonly use staging of the optic disc with Armaly’s cup-to-disc ratio, but this method has variable

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intra- and interobserver reliability and does not take into account focal narrowing of the neuroretinal rim or disc size. Spaeth’s Disc Damage Likelihood Scale directs attention to the narrowest area on the optic disc’s rim, accounts for disc size, and is more reliable than the cup-to-disc ratio (Figure 2). Practitioners can make drawings of the optic nerve head for documentation, but they are often inaccurate, lacking in detail, and poorly reproducible.

Sequential optic disc imaging allows important features to be recorded permanently for future reference. For patients with glaucoma, it is prudent to obtain an image of the optic disc annually for comparisons. More frequent imaging should be considered for patients at high risk of progression such as those who demonstrate a disc hemorrhage, a possible change in the optic disc on clinical examination, or visual field changes.

**IMAGE-ANALYSIS TECHNOLOGY**

Image-analysis machines are becoming increasingly popular for the evaluation of the optic disc for glaucomatous damage and for monitoring disease status. The common technologies are scanning laser polarimetry, retinal tomography, and optical coherence tomography (OCT).

Scanning laser polarimetry is performed by a confocal scanning laser ophthalmoscope with an integrated polarimeter (GDx; Carl Zeiss Meditec, Inc., Dublin, CA). A polarized light beam is projected into the eye. The polarization of the light alters when it encounters the RNFL, and this change is proportional to the thickness of the tissue. Heidelberg retinal tomography (HRT; Heidelberg Engineering GmbH, Heidelberg, Germany) uses a diode laser to sequentially scan the retinal sur-
face in the horizontal and vertical directions at multiple focal planes. A 3-dimensional topographic image is constructed from a series of optical image sections at consecutive focal planes.\textsuperscript{13,14} OCT uses a low-coherence near-infrared light beam, which is directed onto a partially reflective mirror (beam splitter) that creates two light beams: a reference and a measurement beam. The measurement beam is directed onto the patient’s eye and is reflected from the intraocular tissues. The reference beam is reflected from the reference mirror at a known, variable position. The pattern of interference between the two beams is used to provide information regarding the distance and thickness of the retinal structures.\textsuperscript{13,14}

Investigators have compared the diagnostic ability of image analyzers against the qualitative evaluation of optic disc stereophotographs. Vessani et al found that the diagnostic ability of the Stratus OCT (Carl Zeiss Meditec, Inc.), HRT III, and GDx (area under the curve [AUC] 9.92 ±0.03, 0.83 ±0.04, 0.91 ±0.03, respectively) performed better than subjective assessment of the optic nerve head from stereophotographs by the general ophthalmologist (AUC = 0.80 ±0.04) but not by a glaucoma expert (AUC = 0.92 ±0.03).\textsuperscript{15} Badala et al found that the Stratus OCT, GDx, and HRT III performed as well as, but not better than, qualitative evaluation of optic disc stereophotographs for the detection of early perimetric glaucoma.\textsuperscript{16} It is also important to note that Medicare currently does not reimburse clinicians for optic disc photography (CPT code 92250) and image-analyzer examinations (CPT code 92135) that are performed on the same day.

CONCLUSION

Technological advances have augmented the diagnosis and management of many diseases, and glaucoma is no exception. Image-analyzing technologies that aid in the evaluation and documentation of the optic nerve head’s structure in glaucoma have evolved tremendously during the past 2 decades and now allow automation, improved image resolution, and quantification of optic disc parameters. These image analyzers also provide topographical data on the optic disc that are more accessible in an electronic format than the stereoscopic information from optic nerve stereophotographs.

Nevertheless, these technologies have their limitations. Like optic disc photography, the quality of the data obtained from image analyzers varies and is still dependent on the operator's skill and the clarity of patients’ ocular media. The rapid advances in these technologies are associated with the costs of replacing quickly outdated machines and difficulty in comparing the output of newer machines with that of incompatible, earlier units. In addition, no consensus has been reached on a dominant technology, and the assessment of optic nerve edema, pallor, and peripapillary hemorrhages still requires clinical evaluation or photography. Finally, despite the potential of improved objectivity and reproducibility, the image analyzers have not been convincingly shown to perform better than the evaluation of optic disc stereophotographs for the diagnosis and monitoring of glaucoma. Imaging technology may become increasingly useful as it continues to evolve, but it is currently complementary to clinical examination and optic disc photography in the management of glaucoma.

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