

THE ROLE OF OPTIC NERVE HEAD IMAGING

Past, present, and future.

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Evaluating the optic nerve head (ONH) has long been a vital aspect of detecting and monitoring glaucoma, but the methods of evaluation have evolved. Historically, ONH drawings were the sole record

of the optic nerve's appearance. Since the 1800s, optic disc photography has been considered the gold standard for optic nerve evaluation. Initially, film was used.¹ Now, high-resolution stereo digital images can be obtained to record the ONH's appearance over time. Disc photography offers many advantages over disc drawings, including a more accurate and objective recording. A major disadvantage of

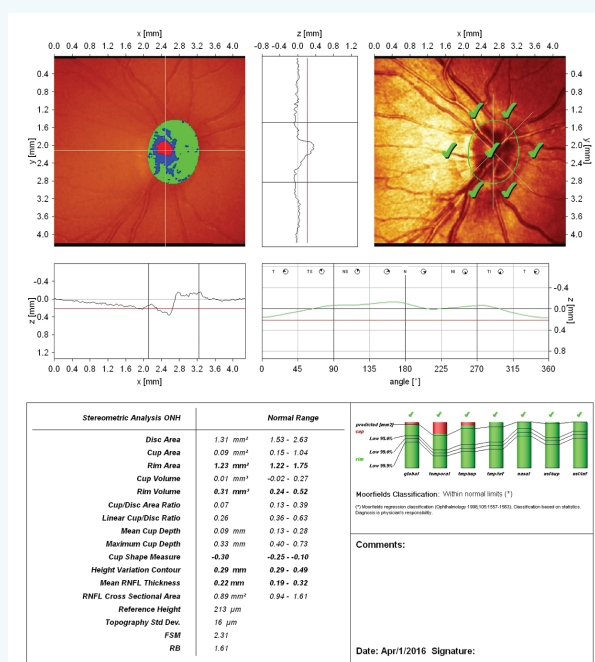
“ A major disadvantage of photography is its qualitative nature, which makes subtle changes in the disc difficult to detect.”

photography is its qualitative nature, which makes subtle changes in the disc difficult to detect and renders disc assessment prone to interobserver variability. Additionally, patients generally dislike the pupillary dilation and bright lights required for photographs, although it should be noted that newer digital cameras may not require dilation. The desire for more quantitative, convenient, and comfortable methods of evaluating the optic nerve has led to the development of various imaging techniques.

CURRENT METHODS OF ONH IMAGING

Computer-assisted imaging, including confocal scanning laser ophthalmoscopy (CSLO; Heidelberg Retinal Tomograph [HRT; Heidelberg Engineering]) and optical coherence tomography (OCT) have emerged as popular methods for assessing the optic nerve. The HRT uses a laser to create a 3-D image of the optic nerve. Parameters measured include area and volume of the disc, disc rim, cup depth, and the cup-to-disc ratio (Figure 1). These parameters are compared to a normative database using the Moorfields Regression Analysis to detect glaucoma and can be monitored for glaucomatous progression.² Newer software such as the Glaucoma Probability Score are not dependent on manual outlining of the optic disc margin² and may be more accurate than prior HRT software.

OCT measures the thickness of the retinal nerve fiber layer (RNFL) using reflected light and the principle of interferometry. Depending on the precise light used, OCT devices are classified as either time domain or spectral (also known as Fourier) domain. In addition to the analysis of RNFL



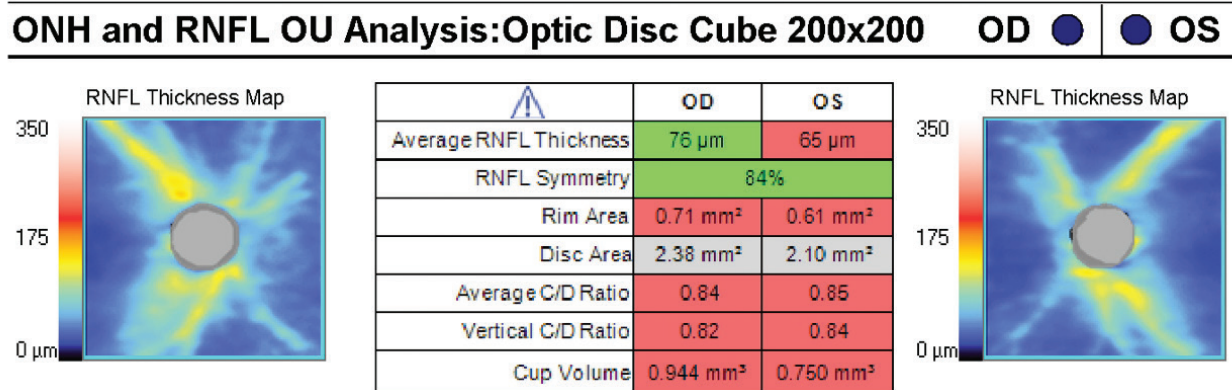


Figure 2. This portion of the OCT printout shows the optic nerve parameters measured.

parameters, OCT provides data regarding the optic disc and rim area, average and vertical cup-to-disc ratio, and cup volume (Figure 2). Similar to the HRT, progression analysis software of the OCT devices is based on a comparative database.

Advantages of computer-assisted imaging techniques include the quantitative assessments and the patient-friendly process (eg, no pupillary dilation, no bright lights, quick test time). Moreover, the quantification of disc size allows clinicians to better assess the relevance of an enlarged cup-to-disc ratio.³ Limitations of computer-assisted imaging techniques include its rapidly evolving technology, with frequent software upgrades that potentially limit the clinician's ability to compare data. Additionally, the cost of purchasing and upgrading software may be prohibitive. Lastly, image quality depends on the examiner's skill, media opacity, pupillary size, and machine-induced artifacts.³



AT A GLANCE

- The clinical examination, visual field testing, and the assessment of the optic nerve by stereo photographs are the gold standards for diagnosing glaucoma and detecting its progression.
- Computer-assisted imaging of the optic nerve head can provide adjunctive information to aid the diagnosis of glaucoma patients and possibly monitoring them for disease progression.
- Computer-assisted imaging of the optic nerve head may be used as an outcome measure for clinical trials, resulting in faster endpoints and less costly research.

PUTTING IT INTO PRACTICE

Diagnosing glaucoma can be difficult, especially when structural changes precede visual field changes.^{4,5} Computer-assisted imaging may be useful in detecting the disease. Ancillary analysis of data from the Ocular Hypertension Treatment Study (OHTS) suggests that optic nerve parameters measured by CSLO may predict the risk of developing glaucoma.^{3,6} OCT analysis of the optic nerve rim area may also be helpful in diagnosis but is likely inferior to OCT analysis of the RNFL.^{5,7} Other studies suggest that ONH parameters are comparable to RNFL parameters in detecting both pre- and perimetric glaucoma.⁸

Detecting glaucomatous progression may also be a challenge, particularly with subtle changes of the optic nerve. Studies conflict regarding the ability of CSLO and OCT to predict visual field loss, but thinning of the rim area on CSLO appears to occur faster in eyes that subsequently develop visual field loss.⁹⁻¹⁵ Both CSLO and OCT show increasing sensitivity with increased severity of disease.^{16,17}

It is critical for the clinician to use ONH imaging in conjunction with the clinical examination and visual field testing. A "normal" imaging test may be as informative as—or possibly more so than—an "abnormal" test. For instance, in a study comparing spectral-domain OCT, standard automated perimetry, and stereo photography, most eyes with detectable disease progression were identified with only one testing method (low positive predictive ability). Interestingly, there was a large amount of agreement among all three methods for eyes in which glaucoma was not progressing (high negative predictive ability).¹⁸ Although possible disease progression as detected by one method may not warrant escalating treatment, the lack of progression, as determined by several methods, may allow clinicians to confidently continue their current treatment course.

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LOOKING FORWARD

Glaucoma clinical trials often use structural endpoints, the gold standard being standard disc photography.³ Computer-assisted imaging may be a useful adjunct in clinical trials. It may detect disease progression faster than photography, enabling clinical endpoints to be reached faster and resulting in quicker and less costly trials. Moreover, the use of imaging in clinical trials would serve to enlarge and expand the cohort used for progression analysis software.³ ■

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