

Evaluating Optic Nerve Head Topography

Topographic measurements can provide valuable information for several stages of glaucoma management.

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Glaucoma-related neural losses result in characteristic structural changes to the optic nerve head (ONH) and peripapillary retinal nerve fiber layer (RNFL) such as a loss of the neuroretinal rim and diffuse or localized RNFL defects. The clinician's recognition of ONH topographical changes is therefore important for diagnosing glaucoma and detecting progression, particularly because structural changes often precede observable defects on perimetry.

Stereophotography has been the gold standard for assessing optic disc damage in glaucoma. Because analysis of disc photographs is subjective and interpretation can vary widely, objective imaging technologies such as confocal scanning laser ophthalmoscopy (CSLO) and optical coherence tomography (OCT) have been developed to assess optic disc topography. Substantial evidence exists that CSLO and OCT measurements of the ONH can provide useful information for several stages of glaucoma management.

CONFOCAL SCANNING LASER OPHTHALMOSCOPY

In cases of ocular hypertension, ONH measurements are valuable for estimating the patient's risk of developing glaucoma, as demonstrated in the Ocular Hypertension Treatment Study (OHTS).¹⁻³ The OHTS showed that baseline CSLO measures such as a large cup-to-disc ratio, a small rim area, and a small rim vol-

ume are significantly associated with an increased risk for the future development of glaucoma.¹

Medeiros and colleagues recently showed that, in patients with suspected glaucoma, longitudinal changes in ONH topography, as measured with CSLO, were highly predictive of the future development of glaucomatous visual field loss.⁴

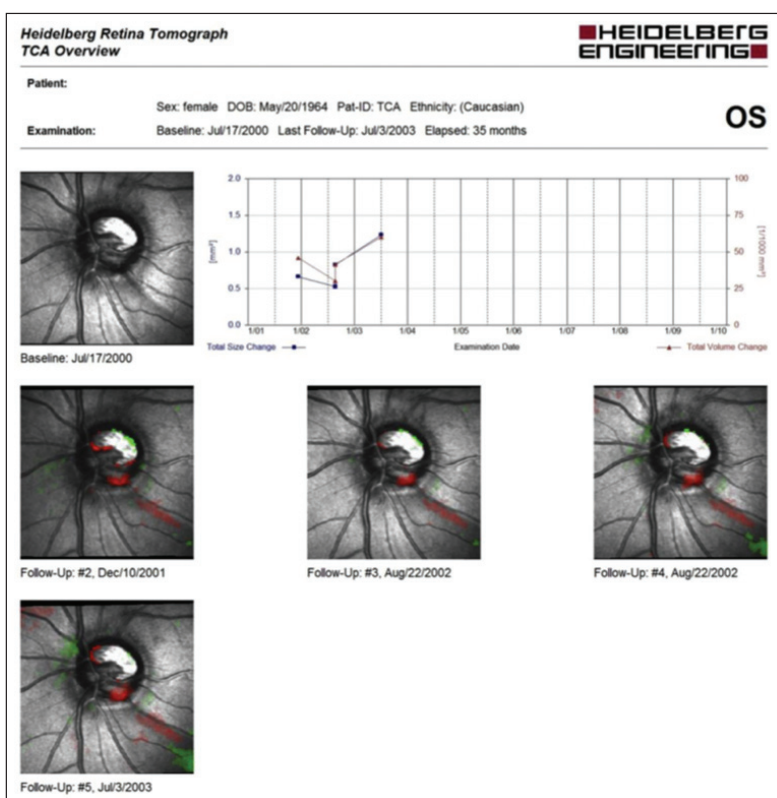


Figure 1. An example of topographic change analysis on CSLO showing progressive structural changes in the optic disc.

The study enrolled patients with normal visual fields but suspicious optic discs (defined as neuroretinal rim thinning, excavation, or suspicious RNFL defects) or elevated IOP (> 21 mm Hg) at baseline. Patients underwent regular CSLO examinations for more than 6 years on average. Eyes that developed visual field loss during follow-up had four times greater rates of neuroretinal rim loss than those that did not, with each 0.01 mm^2/year faster rate of rim area loss associated with an almost threefold higher risk of developing visual field loss. The authors also demonstrated how the results of this study could be used to create a longitudinal risk calculator (ie, a risk model for the development of visual field loss in glaucoma suspects that can be updated as information on predictive factors is made available over time). Such a tool would be a significant improvement over current risk calculators that rely only on baseline information.

There is also evidence that measurements of ONH topography are useful in patients with established glaucoma. For example, Chuahan and colleagues demonstrated that longitudinal changes in rim area, measured using the CSLO topographic change analysis (Figure 1)—an event-based technique for detecting change in the optic disc—are associated with an increased risk of progressive visual field loss.⁵

There are some limitations to ONH topographic measurements using CSLO. One disadvantage is that they are influenced by variations in IOP. For example, an increase in neuroretinal rim area is often observed after glaucoma surgery. There are also racial differences in disc topography; black individuals tend to have significantly larger optic discs. It is therefore necessary to consider both race and optic disc size when evaluating ONH topography.⁶ It is also important to appreciate that, unlike with stereophotographs, some features useful for the assessment of glaucoma such as disc hemorrhages and peripapillary atrophy are not as visible using certain imaging devices.

SPECTRAL-DOMAIN OCT

Although in clinical practice OCT is used primarily to assess RNFL thickness, technological advances are making this tool increasingly attractive for assessing other topographical features of the ONH such as the neuroretinal rim. Spectral-domain OCT (SD-OCT) offers improved image resolution, the ability to obtain detailed three-dimensional images of the ONH, and the versatility to image multiple retinal layers in the circumpapillary and macular regions.

SD-OCT has also improved clinicians' understanding of ONH anatomy and has shown that currently widely used methods for measuring the neuroretinal rim may be suboptimal. By comparing SD-OCT and optic disc stereophotographs, Reis and colleagues discovered that current

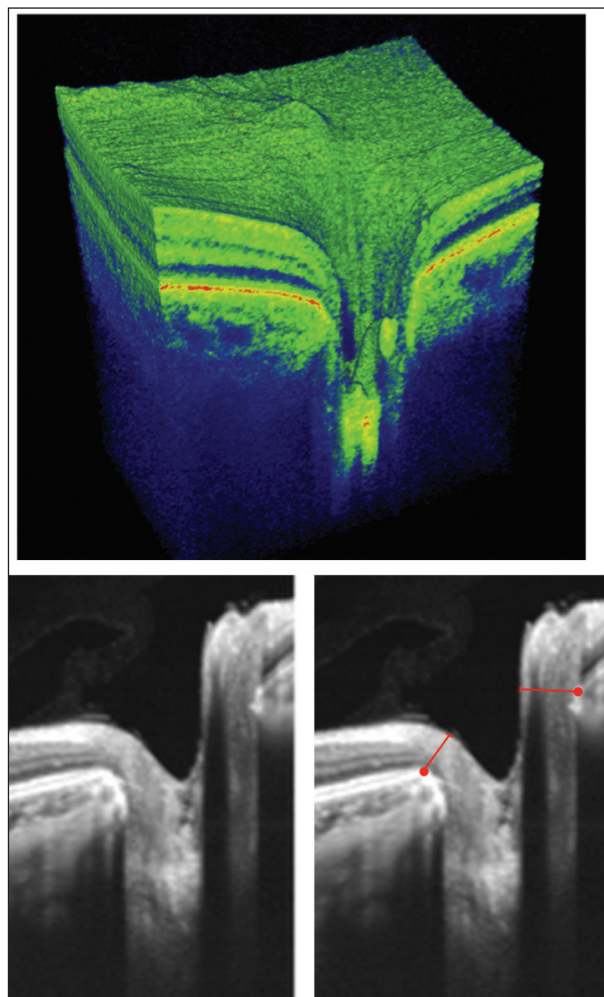


Figure 2. Three-dimensional SD-OCT scan of an eye with glaucoma (upper panel) showing a magnified view of the ONH with BMO-MRW shown by the red lines (lower panels).

measurements of rim width “lack a solid anatomic foundation.”⁷⁻⁹ The neuroretinal rim is typically delineated by the optic disc margin (outer border) and optic disc cup (inner border). The problem is that the clinically identifiable optic disc margin is inconsistent and formed by a variety of structures, so it does not represent an anatomically consistent reference for the outer border of the neuroretinal rim. In fact, because Bruch membrane often extends below the disc margin, the neuroretinal rim may be thinner than it appears clinically.

It has subsequently been shown that the termination of Bruch membrane or Bruch membrane opening (BMO) can provide a more anatomically consistent reference point for the outer border of the neuroretinal rim. Because measurements of rim thickness also vary depending on the orientation of rim tissue, it has

been proposed that the most consistent measurement should be the minimum distance from BMO to the internal limiting membrane.⁷⁻⁹ This measurement, which has been termed *BMO minimum rim width* (BMO-MRW; Figure 2), shows promise for glaucoma assessment. Recently, Chauhan and colleagues calculated BMO-MRW using SD-OCT and evaluated the diagnostic performance of this measure in glaucoma. BMO-MRW was found to have an area under the receiver-operating characteristic curve of 0.96 (95% CI, 0.92-1.00), with a sensitivity of 81% at 95% specificity. This was superior to SD-OCT RNFL thickness (area under the receiver-operating characteristic curve of 0.92 [95% CI, 0.88-0.96], 70% sensitivity at 95% specificity).⁹ Further studies need to be performed to fully validate the usefulness of this method, particularly with respect to the detection of longitudinal change over time.

CONCLUSION

The introduction of imaging technologies such as CSLO and OCT has enhanced clinicians' ability to evaluate ONH topographic changes in glaucoma. Imaging has also improved understanding of ONH anatomy, leading to the development of more consistent reference markers such as BMO-MRW, with the potential to further improve glaucoma diagnosis and the assessment of longitudinal structural changes. ■

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