

USING OCT TO MEASURE ANTERIOR LAMINA CRIBROSA DEPTH

A look at the role of OCT and the relationship between the depth of the lamina cribrosa, the stage of glaucoma, and the extent of vision loss.



BY SAHAR BEDROOD, MD, PhD

Ophthalmology is one of the few specialties in which diagnostic imaging provides detailed information about the tissue in question and plays a crucial role in the identification and treatment of disease. In the era before diagnostic imaging modalities such as OCT, physicians relied on key clinical features of the optic nerve head (ONH) and lamina cribrosa (LC) to identify the presence and extent of glaucoma.

Features such as excavation or backward bowing of the LC, presence of laminar dots, and an increased vertical cup-to-disc ratio offered insights into the extent of retinal nerve fiber layer (RNFL) thinning and scleral exposure seen at the level of the LC (Figure 1).¹ Although these clinical features continue to be important in the assessment of the stage and progression of glaucoma, they can be subjective and do not provide as much fine detail as OCT.

THE LC IN FINER DETAIL

OCT provides high-resolution imaging of the layers of the retina, choroid, sclera, and ONH. It also gives information about the extent of RNFL loss near the ONH and the extent of ganglion cell layer loss in the macula. In addition to these well-known diagnostic analyses, it is now possible to locate and quantify the anterior lamina cribrosa depth (ALD) using spectral-domain OCT. The ALD is the deepest point below the opening of Bruch membrane (Figure 2), and it has been shown to correlate with the stage of glaucoma, change in IOP, visual field loss, race, and age.¹⁻³

In a paper by Park et al,⁴ the ALD of normal eyes was compared with eyes that had different stages of treated glaucoma. The investigators measured the ALD in each eye by averaging 11 equally spaced horizontal B-scans across the ONH, which allowed them to calculate the depth of the LC. They found that posterior LC displacement occurred mostly in eyes with preperimetric and mild to moderate glaucoma.

No significant difference was seen in eyes with moderate to severe glaucoma. This finding suggests more fluidity and movement within the sclera early in the disease that may be lost in advanced stages.

This fluidity of movement raises the question: What happens to the LC depth when IOP changes in these patients? In a study of 100 eyes with primary open-angle glaucoma, a significant decrease in LC depth was found when IOP was reduced by 20%. The magnitude of LC depth reduction was significantly associated with younger age, higher untreated IOP, higher baseline IOP, and greater percentage of IOP reduction (all $P < .02$). The investigators concluded that the degree to which the LC was displaced was related to IOP lowering.⁵

Moreover, Quigley et al⁶ suggested that eyes with more advanced glaucomatous damage also exhibited a smaller response to changes in ALD with IOP fluctuations. In their study, 28 patients were imaged before and after

AT A GLANCE

- ▶ As imaging modalities and their software advance, ophthalmologists may be able to use the changes to the optic nerve head and lamina cribrosa to yield clinically relevant information.
- ▶ Future imaging will likely entail the development of software algorithms to show change in the anterior lamina cribrosa depth and the measurement of strain behind the lamina cribrosa.

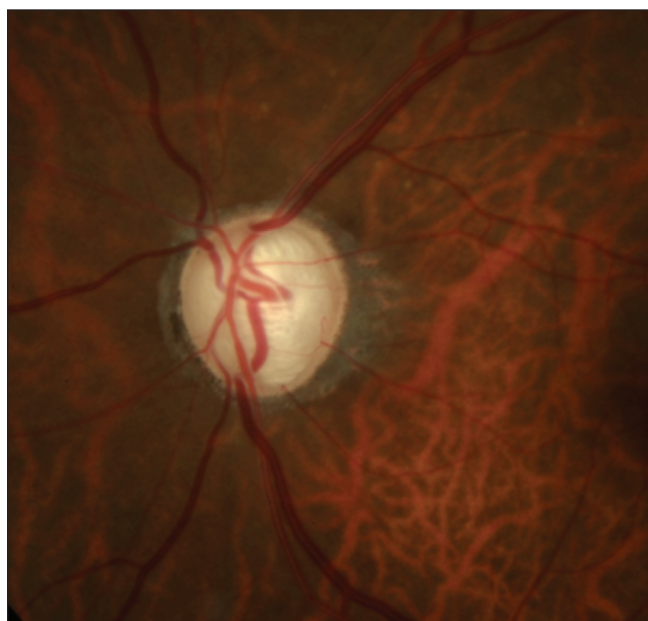


Figure 1. A deeply excavated optic nerve with evidence of laminar dots and scleral beams.

IOP lowering, and ALD was measured with six radial scans before and after the change in IOP (Figure 3). The investigators found that the anterior LC can move anteriorly or posteriorly with IOP reduction and that there was less displacement of the LC with more advanced glaucomatous damage.

In addition to the overall gross changes in LC examined in these studies, the focal defects or optic pits found on clinical examination were correlated with defects or laminar holes on the LC found on enhanced-depth imaging OCT.⁷ The presence of these defects on OCT can be signs of weakening of the LC and possible optic nerve damage. If seen early, they may be good indicators for starting or advancing treatment.

CONCLUSION

Investigators have observed the behavior of the LC in relation to the stage of glaucoma, IOP, changes in pressure, patient age, and extent of visual field damage. Their studies suggest that obtaining high-definition imaging of the anterior LC can provide insight into the extent of damage and stage of glaucoma. At present, there is no universal method to quantify these changes, and there is no consensus or algorithm as to how to take these images and measure the LC depth. For example, a uniform scan protocol of whether to use radial or horizontal scans has not been solidified. Additionally, different spectral-domain and swept-source OCT devices yield different imaging algorithms.⁸

Nonetheless, as imaging modalities and their associated software advance, ophthalmologists may be able to use the changes to the ONH and LC to yield clinically relevant information about the stage of glaucoma, the stiffness of the sclera, and the potential response to therapy. Future imaging will likely entail the development of software algorithms

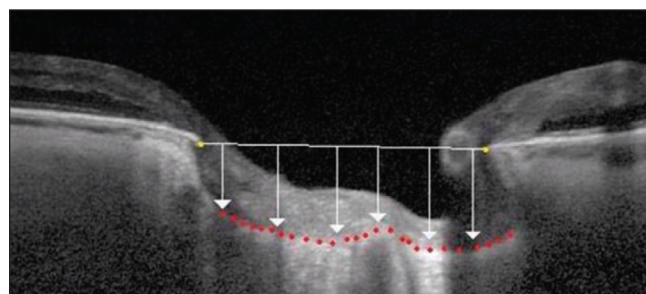


Figure 2. Anterior lamina cribrosa depth, shown by the red dotted line. The opening of Bruch membrane is located at the yellow dots on the horizontal white line.⁶

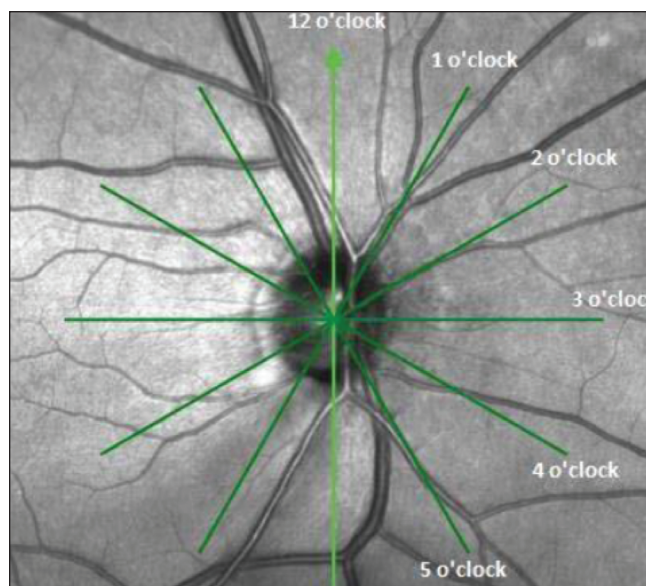


Figure 3. An image of an optic nerve head, showing the location of the six radial scans. Approximately 25 points on each scan were averaged to obtain the anterior lamina cribrosa depth.⁶

to show change in the ALD and the measurement of strain behind the LC. ■

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