OCT in Glaucoma Diagnosis



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Disclosure

- **Michael Chaglasian, O.D. is a paid advisor, consultant or researcher for the following commercial/industry groups:**
  - **Allergan, Alcon Labs, Carl Zeiss Meditec**

Spectral Domain: Many Options



HEIDELBERG ENGINEERING
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Spectral Domain: Many Options

TOPCON CONNECTING VISIONS

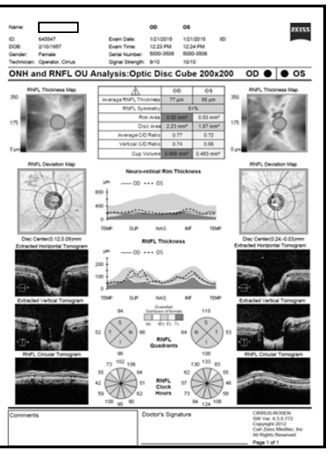


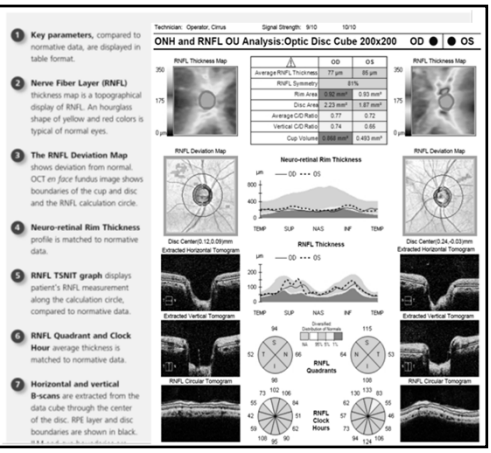
OptosOCT SLO

NIDEK Eye & Health Care NIDEK CO., LTD.

Cirrus SD OCT

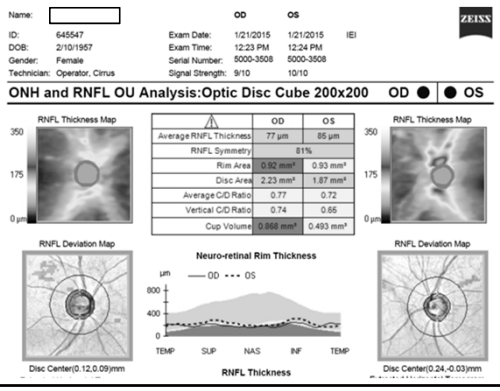
- Glaucoma Applications:
  - RNFL
  - Optic Disc
  - Ganglion Cell Analysis
- Retinal Application:
  - Not Covered here

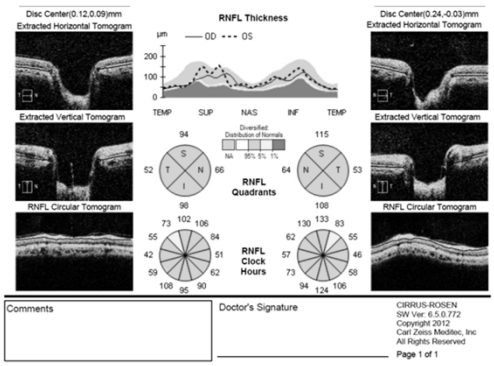




How to "Read" a Printout

- FIRST!: Signal Strength
  - A **KEY** indicator of image quality
  - Should be 7/10 or higher on Cirrus
  - **DO NOT interpret poor quality scan as "red" disease**
- Well centered image
- No evidence of movement artifact
- Review Plots and Displays
  - Thickness Map and Deviation Map
  - Quadrant and Sector Plots
  - TSNIT and Optic Nerve B-Scan Tomograms





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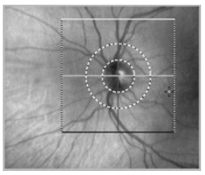
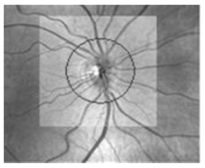
Cirrus RNFL Analysis

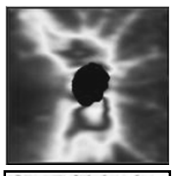


OPTIC DISC CUBE SCAN
The 6mm x 6mm cube is captured with 200 A-scans per B-scan, 200 B-scans.

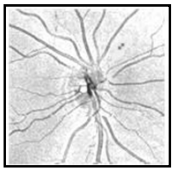


CALCULATION CIRCLE
AutoCenter™ function automatically centers the 1.73mm radius peripapillary calculation circle around the disc for precise placement and repeatable registration.

Glaucoma – RNFL Thickness Analysis



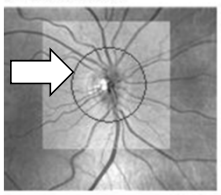
- The **RNFL thickness map** shows the patterns and thickness of the nerve fiber layer within the 6mm x 6mm cube

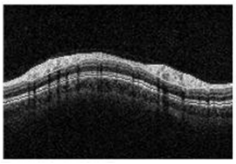


- The **RNFL deviation map** is overlaid on the OCT fundus image to illustrate precisely where RNFL thickness deviates from a normal range

Glaucoma – RNFL Thickness Analysis

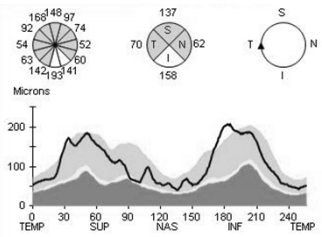
- A **TSNIT** (temporal-superior-nasal-inferior-temporal) circle, with a radius of 1.73mm, is established around the disc
- The LSO fundus image is shown with an OCT fundus overlay. The red circle indicates the location of the RNFL TNSIT circle





Glaucoma – RNFL Thickness Analysis

- RNFL thickness is displayed in graphic format and compared to age-matched normative data



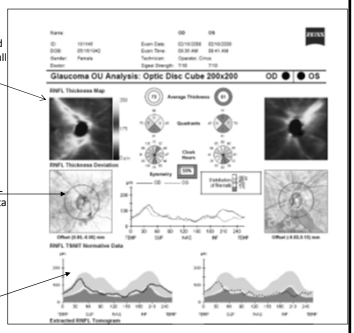
RNFL OU Analysis

RNFL THICKNESS MAP shows the patterns and thickness of the nerve fiber layer within the full 6mm x 6mm area

RNFL thickness and comparison to normative data is shown in circle, quadrants and clock hour display

RNFL DEVIATION MAP, overlaid on the OCT fundus image, illustrates precisely where RNFL thickness deviates from the normal range. Data points that are not within normal limits are indicated in red and yellow.

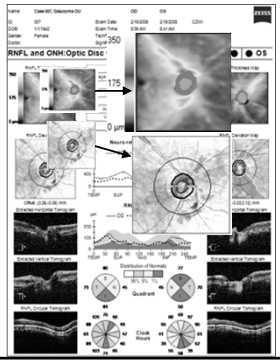
RNFL thickness along the calculation circle is displayed in graphic format and compared to age-matched normative data

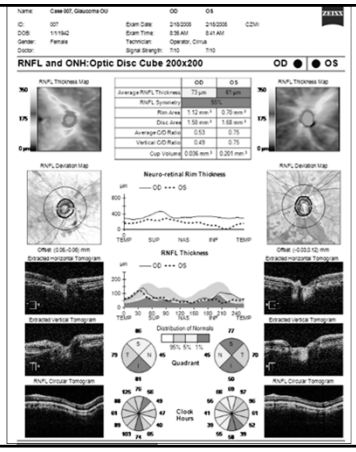


Comprehensive ONH and RNFL Analysis RNFL Calculations

RNFL thickness map with cup and disc mask

- **En face OCT fundus image** shows boundaries of the cup and disc and RNFL calculation circle integrated with the RNFL thickness deviation map
- The deviation map indicates variance from normal





Normative Data: Glaucoma

- Average RNFL Thickness
- RNFL Symmetry
- Rim Area
- Disc Area
- Average C/D Ratio
- Vertical C/D Ratio
- Cup Volume

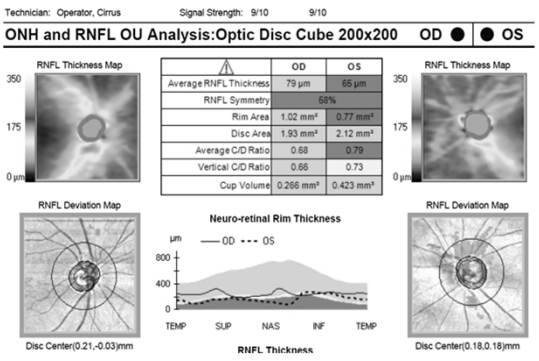
	OD	OS
Average RNFL Thickness	100 µm	101 µm
RNFL Symmetry	90%	
Rim Area	1.60 mm²	1.72 mm²
Disc Area	3.18 mm²	3.45 mm²
Average C/D Ratio	0.69	0.70
Vertical C/D Ratio	0.66	0.69
Cup Volume	0.567 mm³	0.711 mm³

Distribution of Normals:

Color coded indication of normative data comparison for RNFL and ONH.

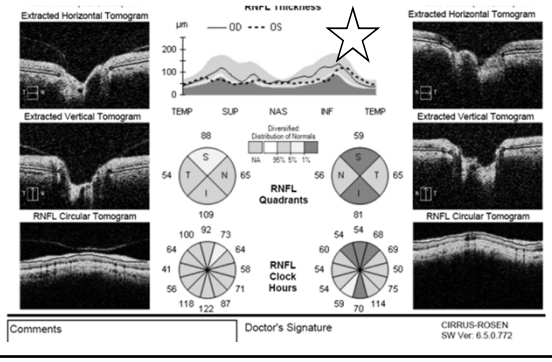
- The thickest 5% fall in the white area.
- 90% of measurements fall in the green area.
- The thinnest 5% fall in the yellow area or below.
- The thinnest 1% of fall in the red area.
- ***Measurements in red are considered outside normal limits.***
- ONH values will be shown in gray when the disc area does not match with normative data.

Example Normative Data:

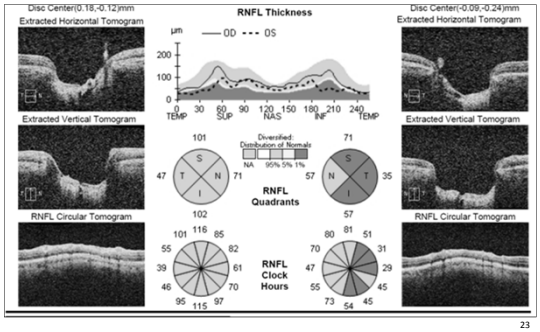


	OD	OS
Average RNFL Thickness	79 µm	66 µm
RNFL Symmetry	58%	
Rim Area	1.02 mm²	0.77 mm²
Disc Area	1.93 mm²	2.12 mm²
Average C/D Ratio	0.68	0.79
Vertical C/D Ratio	0.66	0.73
Cup Volume	0.266 mm³	0.423 mm³

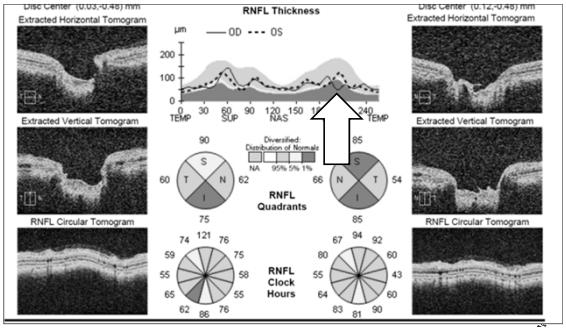
Example Normative Data:



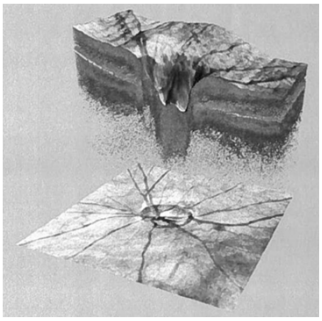
Diffuse Loss OS



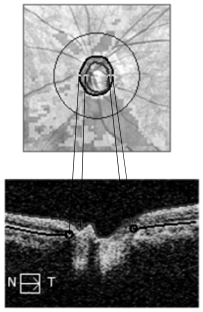
Focal Loss OD



Optic Nerve Head Analysis



Optic Nerve Head Calculations



- The disc edge is determined by the termination of Bruch's membrane. This is validated in the literature. The rim width around the circumference of the optic disc is then determined by measuring the amount of neuro-retinal tissue in the optic nerve. This differs from other methods that determine the cup margin based on its intersection with a plane at a fixed distance above the disc.
- In this method, the disc and rim area measurements correspond to the anatomy in the same plane as the optic disc.

Comprehensive ONH and RNFL Analysis
RNFL and Neuroretinal Rim Displays

Neuroretinal Rim Thickness profile demonstrates symmetry between the two eyes

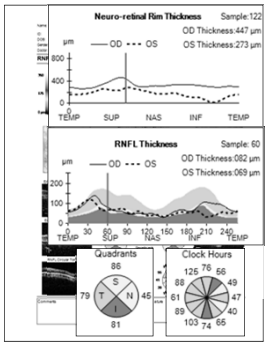
Peripapillary RNFL Thickness profile shows symmetry and anomalies in RNFL structure

RNFL thickness values are compared to normative data

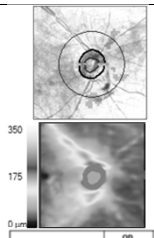
RNFL thickness is compared to normative data in quadrant and clock hour displays

Quadrants may reveal diffuse thinning.

Clock Hours may show localized thinning



Cirrus RNFL and ONH Analysis Elements



OCT *en face* fundus image shows boundaries of the cup and disc and the RNFL calculation circle.

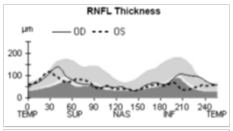
The integrated RNFL thickness deviation map shows deviation from normal

RNFL thickness map also displays cup and disc mask

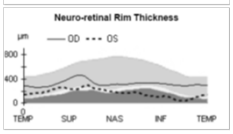
	OD	OS
Average RNFL Thickness	73 µm	61 µm
RNFL Symmetry	65%	
Rim Area	1.12 mm²	0.72 mm²
Disc Area	1.58 mm²	1.72 mm²
Average C/D Ratio	0.53	0.75
Vertical C/D Ratio	0.49	0.77
Cup Volume	0.036 mm³	0.220 mm³

Optic Nerve Head calculations are presented in a combined report with RNFL thickness data. Key parameters are compared to normative data and displayed in table format

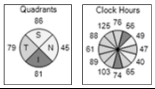
Cirrus RNFL and ONH Analysis Elements



RNFL Peripapillary Thickness profile, OU
- compared to normative data

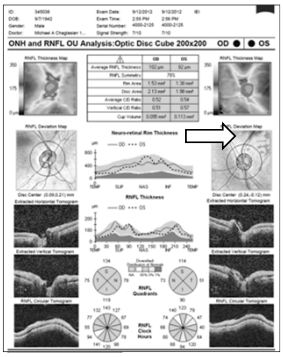


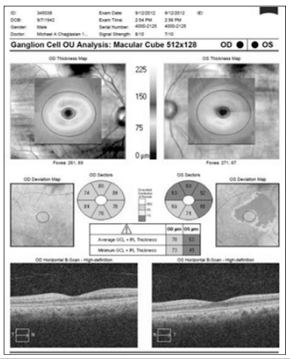
Neuro-retinal Rim Thickness profile, OU
- compared to normative data



RNFL Quadrant and Clock Hour average thickness, OD and OS
- compared to normative data

Zeiss: Cirrus OCT Printouts





IS ALL OF THIS GREAT AND PERFECT??

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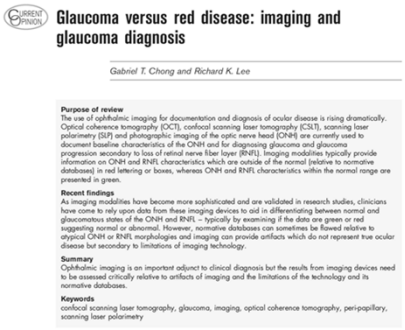
What are practitioners' most common misunderstandings of imaging technology?

"The thought that these devices can diagnose glaucoma ***in the absence of corroborating clinical evidence is***, in my opinion, the most common (and potentially dangerous) misunderstanding.

The limited normative databases against which scans are compared can never cover the remarkably varied appearance and structure of the optic nerve we encounter in normal individuals."

James Brandt, MD

Red Disease!



Glaucoma versus red disease: imaging and glaucoma diagnosis

Gabriel T. Chong and Richard K. Lee

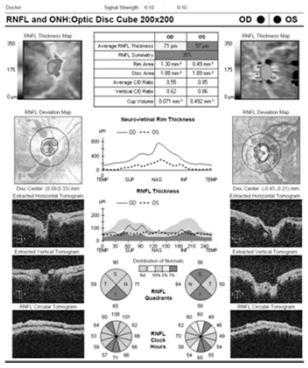
Purpose of review
The use of ophthalmic imaging for documentation and diagnosis of ocular disease is rising dramatically. Optical coherence tomography (OCT), confocal scanning laser tomography (CSLT), scanning laser polarimetry (SLP) and photographic imaging of the optic nerve head (ONH) are currently used to document baseline characteristics of the ONH and for diagnosing glaucoma and glaucoma progression secondary to loss of retinal nerve fiber layer (RNFL). Imaging modalities typically provide information on ONH and RNFL characteristics which are outside of the normal (relative to normative databases) in red lettering or boxes, whereas ONH and RNFL characteristics within the normal range are presented in green.

Recent findings
As imaging modalities have become more sophisticated and are validated in research studies, clinicians have come to rely upon data from these imaging devices to aid in differentiating between normal and glaucomatous states of the ONH and RNFL – typically by examining if the data are green or red suggesting normal or abnormal. However, normative databases can sometimes be flawed relative to atypical ONH or RNFL morphologies and imaging can provide artifacts which do not represent true ocular disease but secondary to limitations of imaging technology.

Summary
Ophthalmic imaging is an important adjunct to clinical diagnosis but the results from imaging devices need to be assessed critically relative to artifacts of imaging and the limitations of the technology and its normative databases.

Keywords
confocal scanning laser tomography, glaucoma, imaging, optical coherence tomography, peri-papillary, scanning laser polarimetry

Red Disease



Read a Printout Summary

- Image Quality
- Step by step to review most plots.
- RNFL and Optic Nerve
- Localized vs. Diffuse
- Normative Data
- Red Disease

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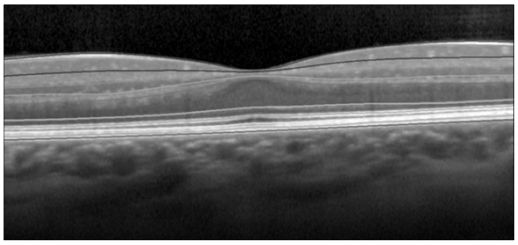
Segmentation Retina/Macula

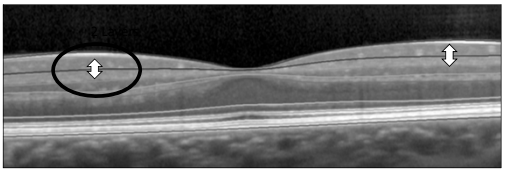


Macula / Ganglion Cell Scans for Glaucoma

- **First noted with older Time Domain OCT (Stratus)**
- **Now all 3 Major OCTs, but with different approaches**

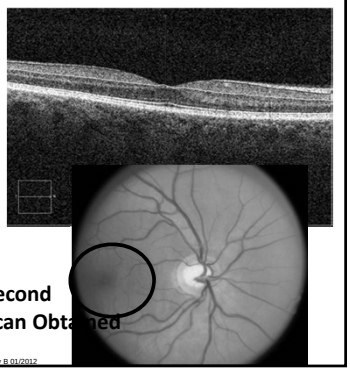
Ganglion Cell Analysis - Zeiss

- Ganglion Cell Layer
- Inner Plexiform Layer
- Theory that the RNFL is too variable and not important in macular assessment



Cirrus: Ganglion Cell Analysis

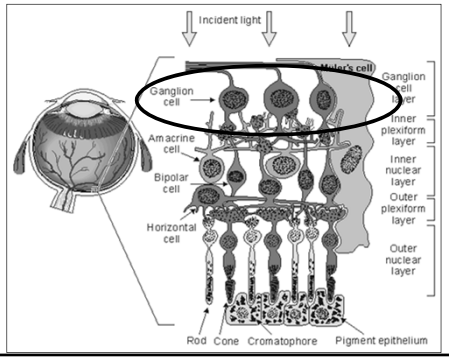
- Measures thickness for the sum of the ***ganglion cell layer and inner plexiform layer (GCL + IPL layers)*** using data from the Macular 200 x 200 or 512 x 128 cube scan patterns.



Second Scan Obtained

Carl Zeiss Meditec, Inc Cirrus 6.0 Speaker Slide Set CIR 3992 Rev B 01/2012

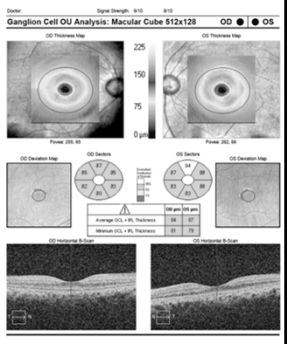
Anatomy: Ganglion Cell Layer and IPL



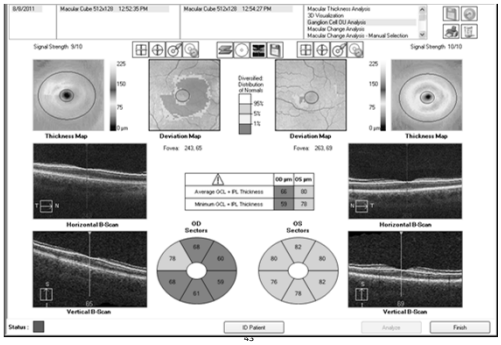
Cirrus: Ganglion Cell Analysis

The analysis contains:

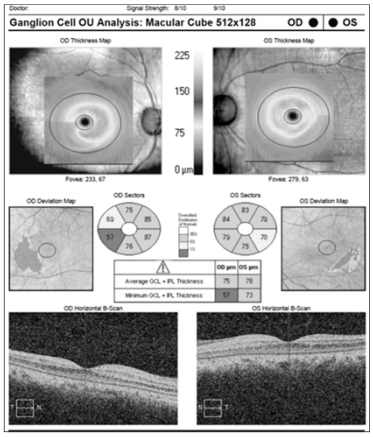
- Data for both eyes (OU)
- Thickness Map –
  - shows thickness measurements of the GCL + IPL in the 6mm by 6mm cube and contains an elliptical annulus centered about the fovea.
- Deviation Maps –
  - shows a comparison of GCL + IPL
  - thickness to normative data.
- Thickness table –
  - shows average and minimum thickness within the elliptical annulus.

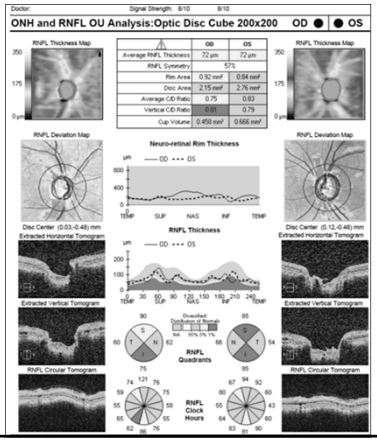


Ganglion Cell Analysis



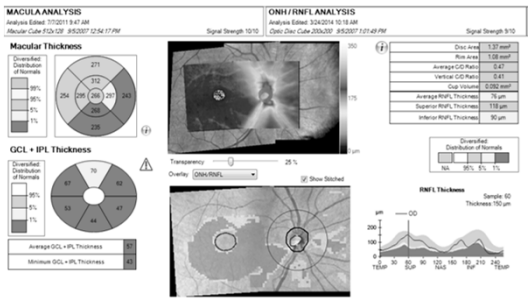
Carl Zeiss Meditec, Inc Cirrus 6.0 Speaker Slide Set CIR.3992 Rev B 01/2012





NEW: PanoMap Analysis

Integration of RNFL, ONH, GCA, and Macular Thickness analyses



Wide-field assessment with high density scans minimizes the need for separate wide-field OCT scan

Macular/Ganglion Cell Analysis for Glaucoma: Key Points

- Is a "complement" to traditional RNFL scans
- Has a large number of false positives.
- Should **NOT** be used as the sole basis of a diagnosis for glaucoma.
- Not proven to make an earlier diagnosis.