Ganglion cell analysis by optical coherence tomography (OCT)

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Figure 1.

Normal OCT of the macula (cross section through the line indicated on the fundus photo)

Figure 2. Layers of the retina seen on OCT

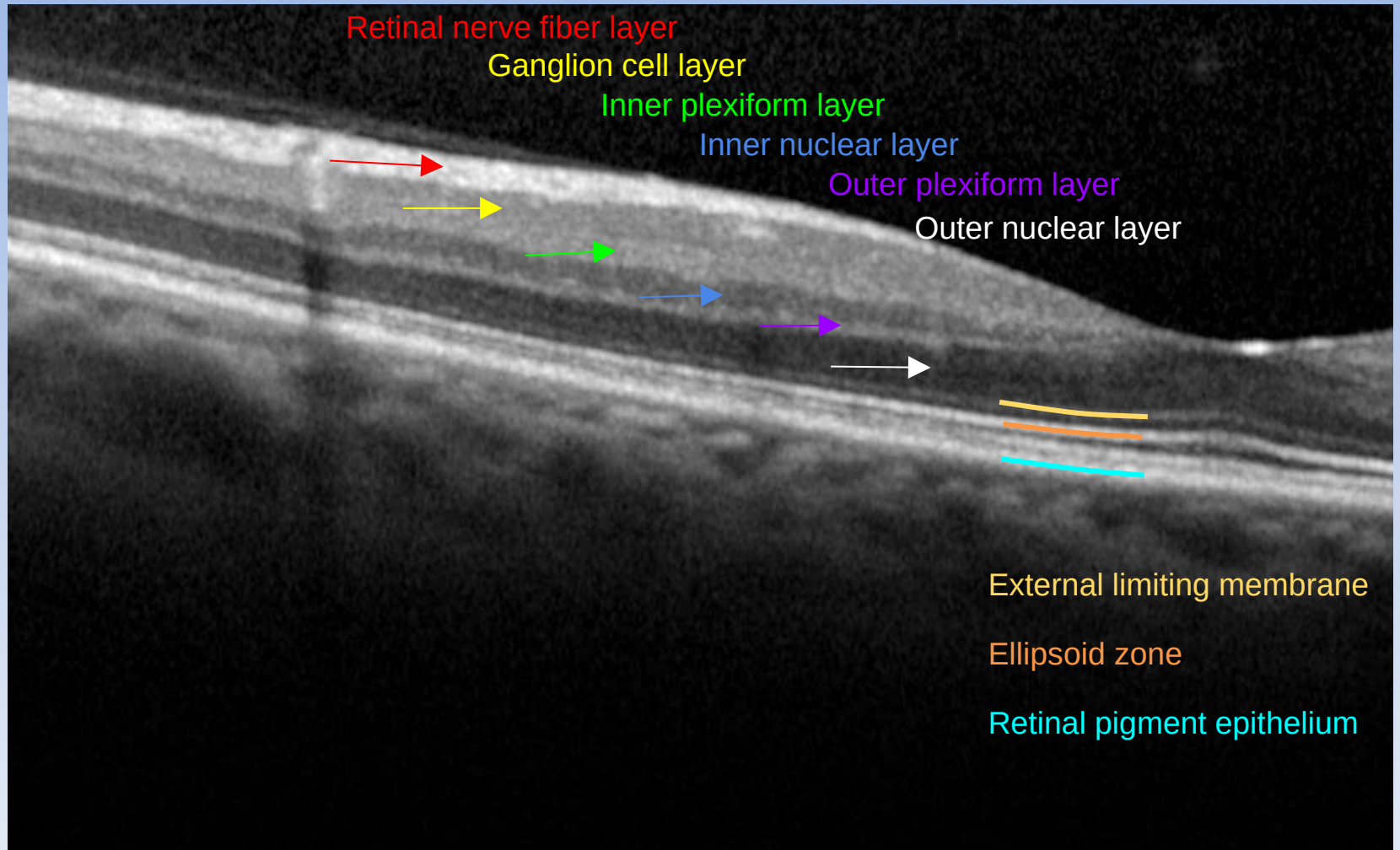
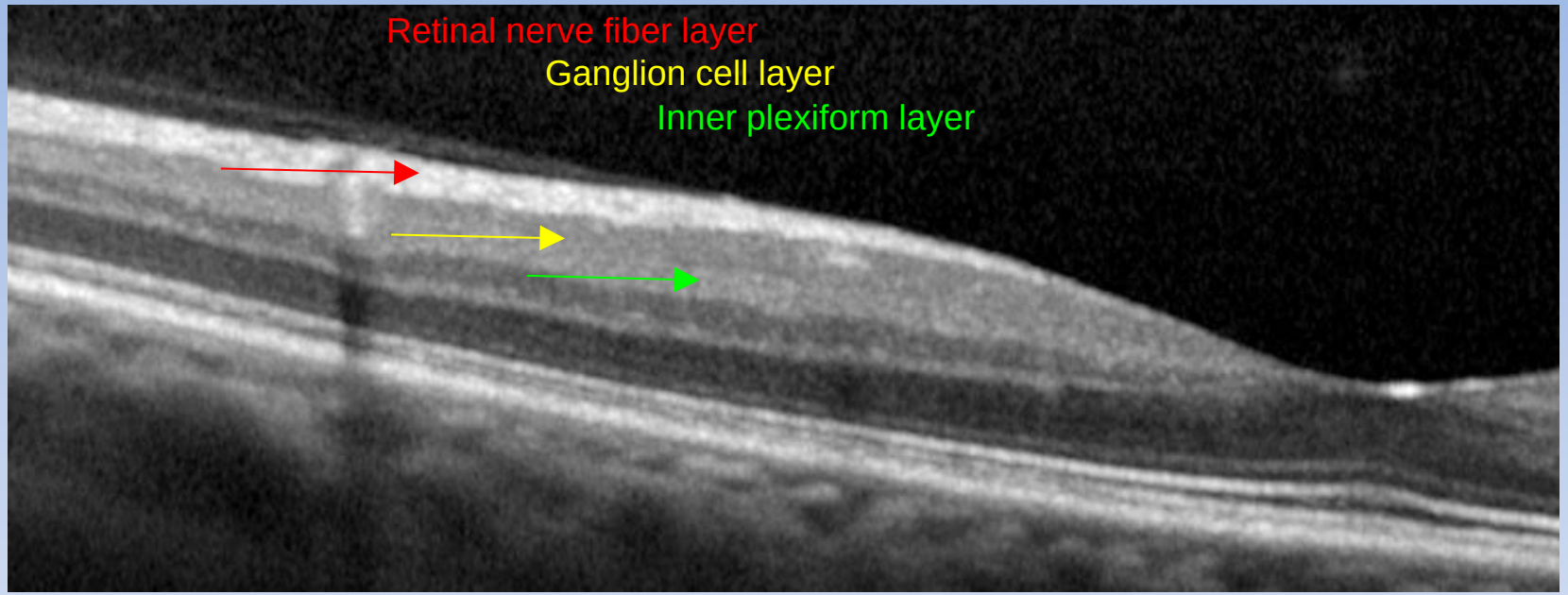


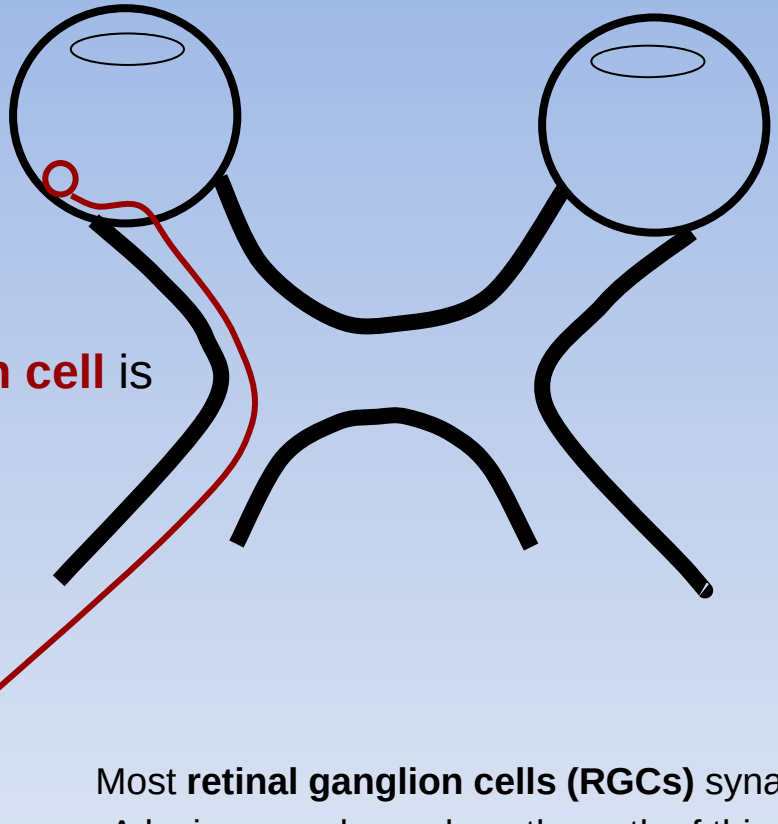
Figure 3. Layers of the retina seen on OCT



- **Ganglion cell layer (GCL)** is composed of cell bodies of retinal ganglion cells
- **Retinal nerve fiber layer (RNFL)** is formed by axons of the retinal ganglion cells
- **Inner plexiform layer (IPL)** consists of axons of bipolar and amacrine cells and dendrites of ganglion cells
- On the Cirrus SD-OCT, the GCL and the IPL are measured together as the **ganglion cell layer complex (GCC)**

Figure 4.

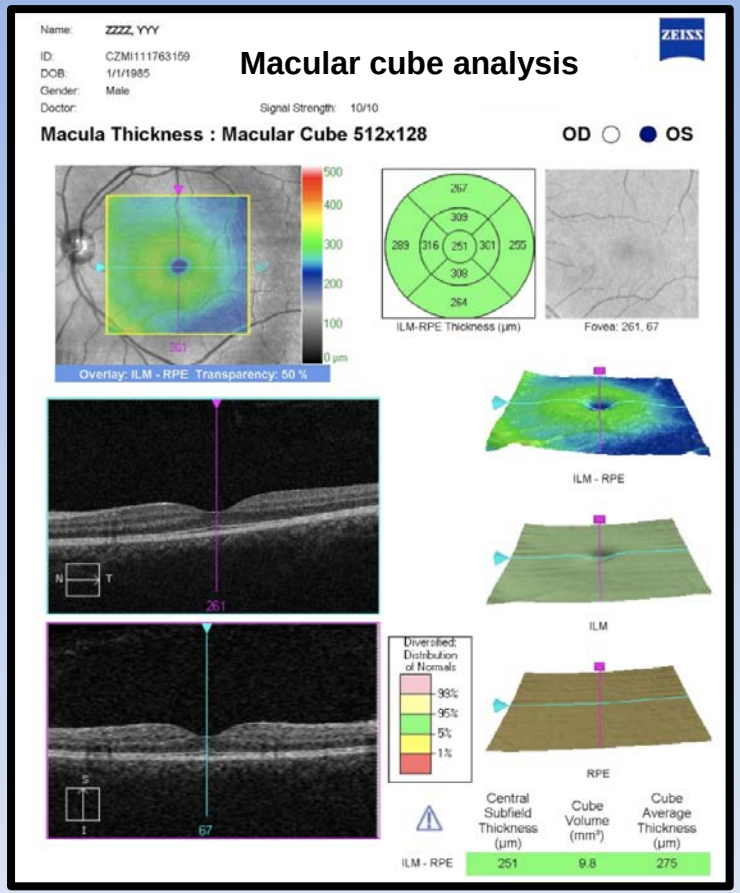
A single **retinal ganglion cell** is shown in red

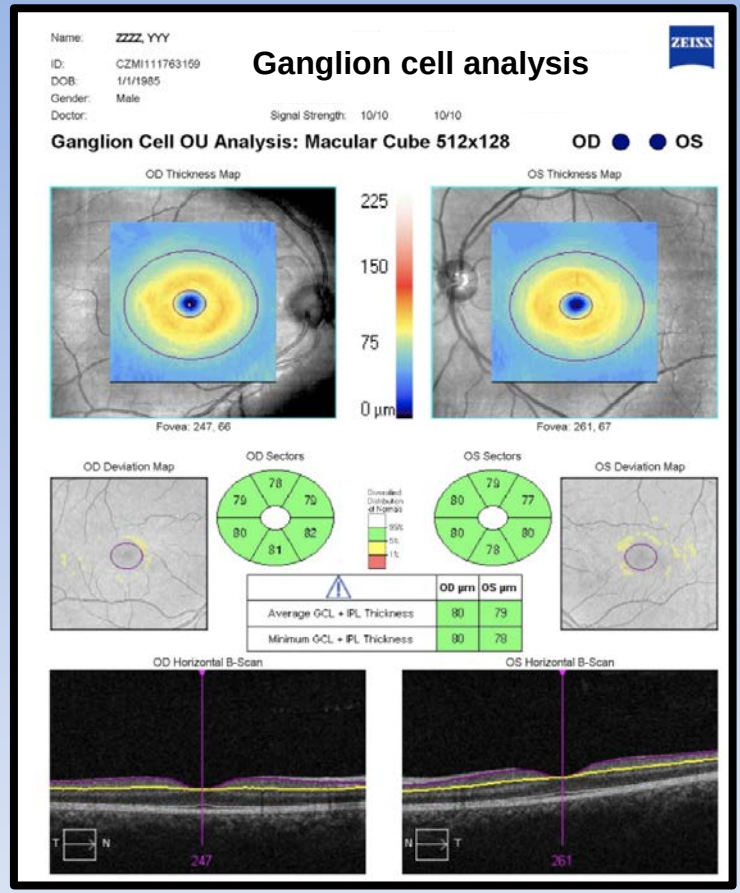


Lateral geniculate nucleus (LGN)

Most **retinal ganglion cells (RGCs)** synapse at the LGN of the thalamus. A lesion anywhere along the path of this RGC can result in cell death and be seen in the retina with OCT.

Figure 5.





Cirrus OCT of a healthy 31-year-old man is shown. From the macular cube analysis shown on the left, the macular ganglion cell analysis can be derived as shown on the right

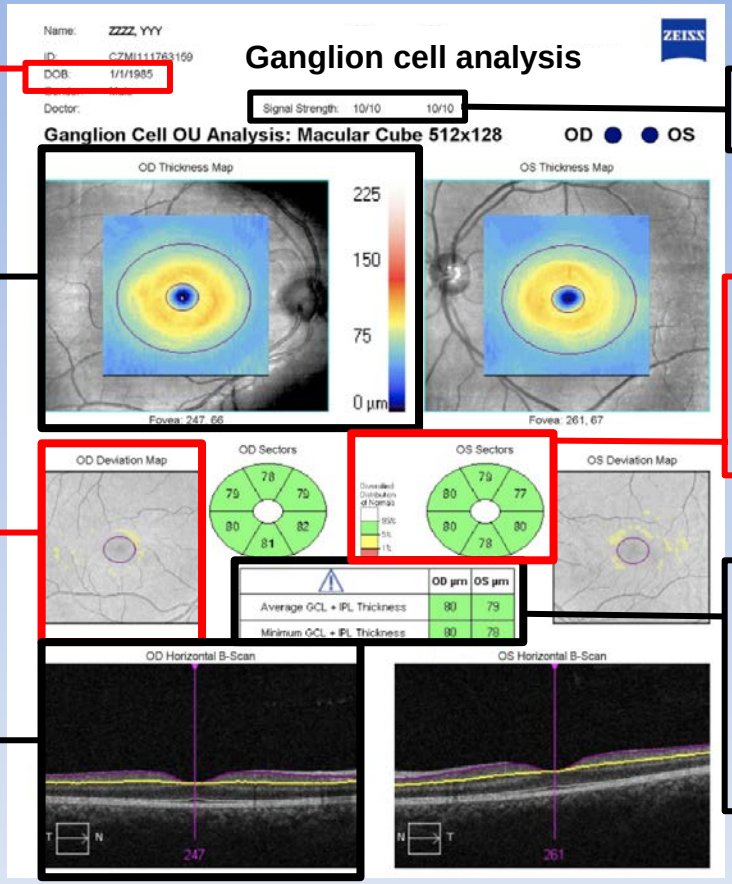
Figure 6. Reviewing the GCL printout

Ensure date of birth is correct

Color thickness map shows thickness measurement of ganglion cell layer (GCL) + inner plexiform layer (IPL)

Deviation map shows GCL+IPL thickness topographically compared to normative data

Horizontal B-scan and overlay of segmentation lines. The purple line represents boundary between RNFL and GCL and the yellow lines represents the boundary between the IPL and INL



Review signal strength

Sector map shows GCL+IPL thickness in sextants, which are color coded in comparison to normative data

Thickness table shows overall GCL+IPL thickness, which is color coded in comparison to normative data

Figure 7.

Case 1

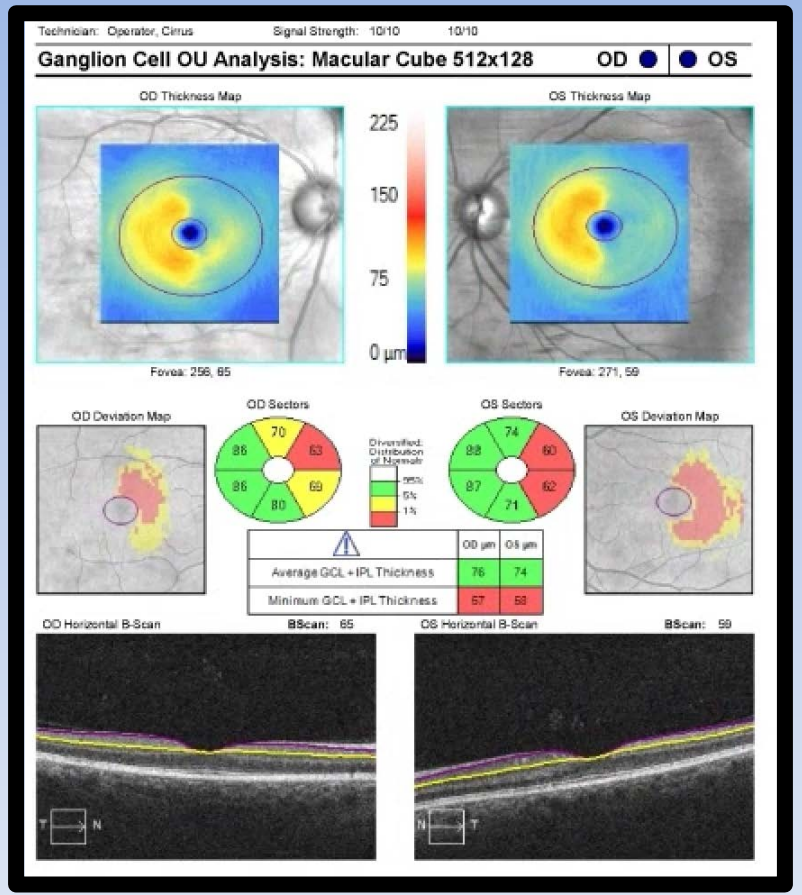
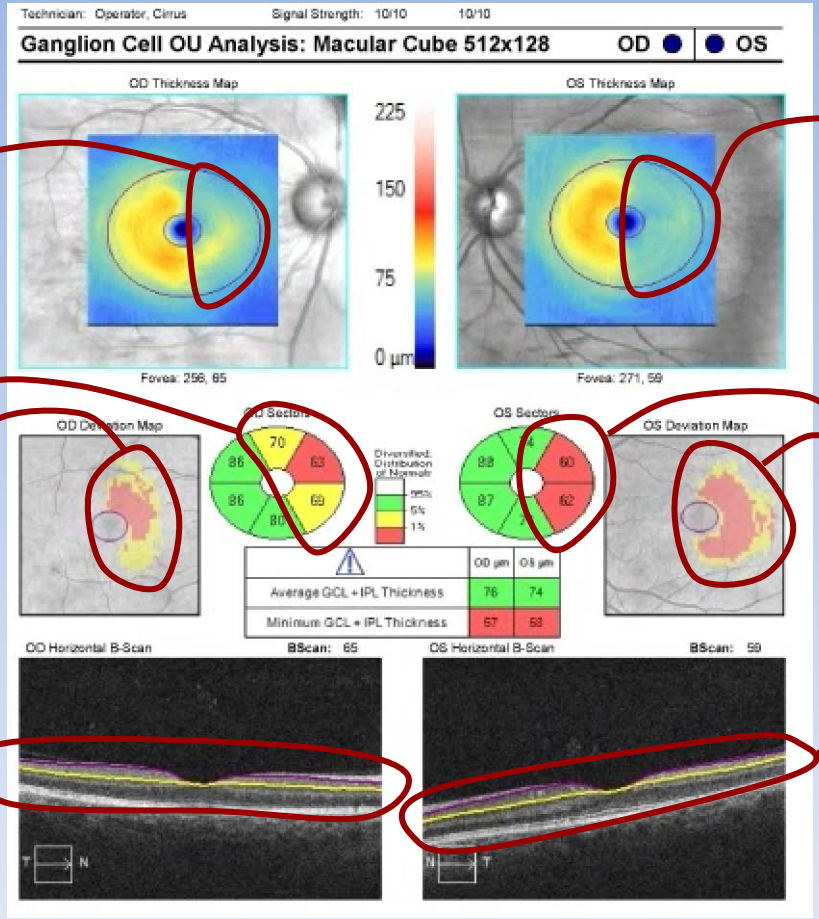


Figure 7.

Case 1



Thickness map shows thinning in nasal retina (blue color compared to yellow-orange in temporal retina)

Thickness map shows thinning in temporal retina (blue color compared to yellow-orange in nasal retina)

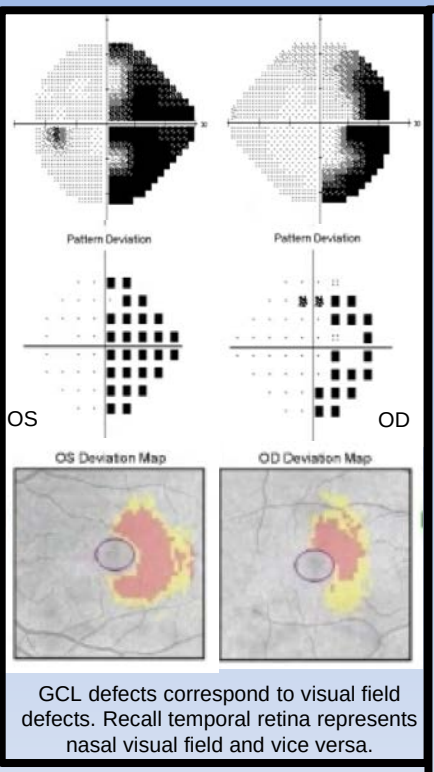
Deviation and sector maps show area in nasal retina (corresponding to temporal visual field) that is thinner than 1% (red) or 5% (yellow) of normal population

Deviation and sector maps show area in temporal retina (corresponding to temporal visual field) that is thinner than 1% (red) or 5% (yellow) of normal population

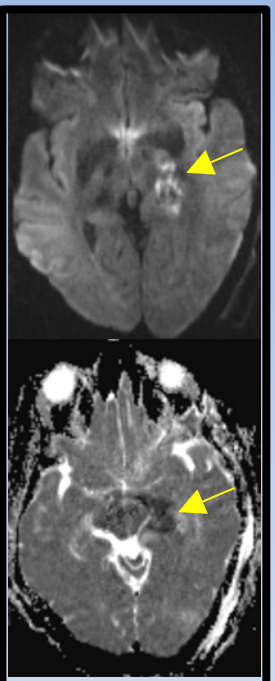
Horizontal B-scan shows segmentation lines that appear in the correct position

Horizontal B-scan shows segmentation lines that appear in the correct position

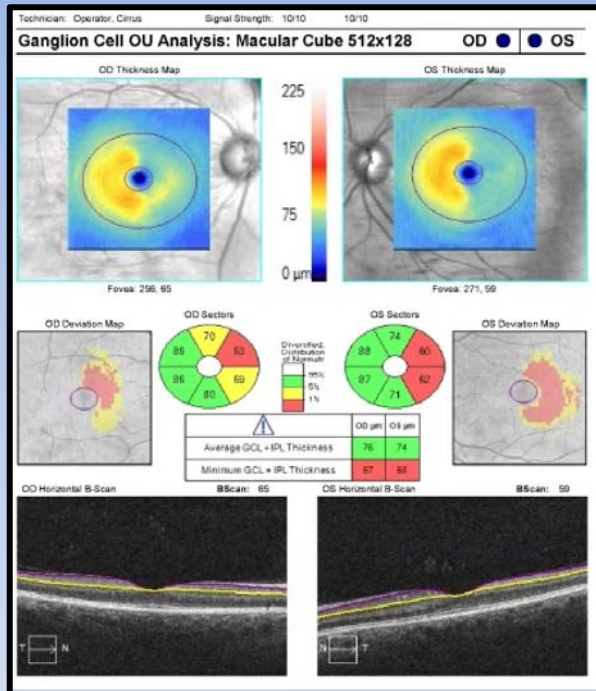
Figure 8. Case 1



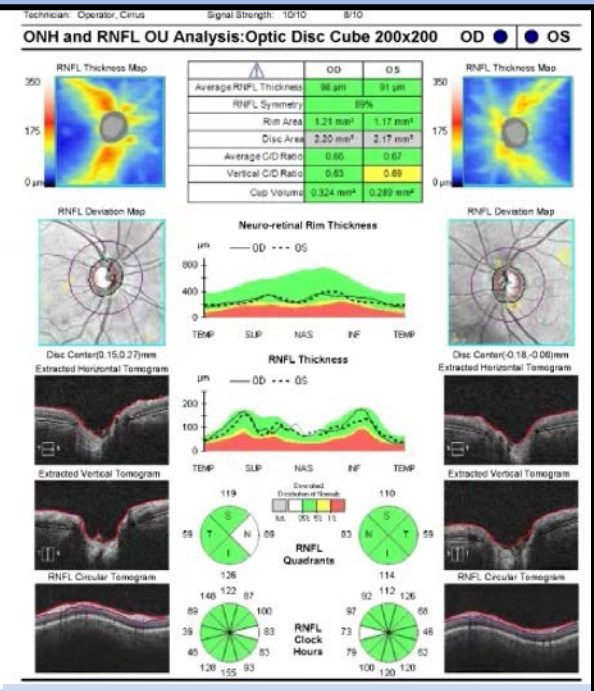
GCL defects correspond to visual field defects. Recall temporal retina represents nasal visual field and vice versa.



DWI (upper) and ADC (lower) maps show infarct in the area of left optic tract



Ganglion Cell Layer analysis



Retinal nerve fiber analysis

This is a 54-year-old woman with a right incongruous homonymous hemianopia due to an ischemic stroke affecting the left optic tract. The visual field and Cirrus OCTs were obtained 2 months after she had right-sided vision loss in both eyes.

Potential pitfalls in interpreting OCT of the ganglion cell analysis

- **Age of the patient** - ensure correct date of birth is entered since thickness measurements are compared against age-matched controls

- **Check signal strength -** reduction in signal strength can result in loss of retinal features and artifacts in in segmentation and interpretation. Signal strength of at least 7/10 is preferable on Cirrus machines

- **Check for errors in segmentation -** an automated algorithm is used to identify inner layer of GCL and outer layer of IPL and may not be correctly identified in patients with macular disease or optic disc edema

Figure 9.

Case 2

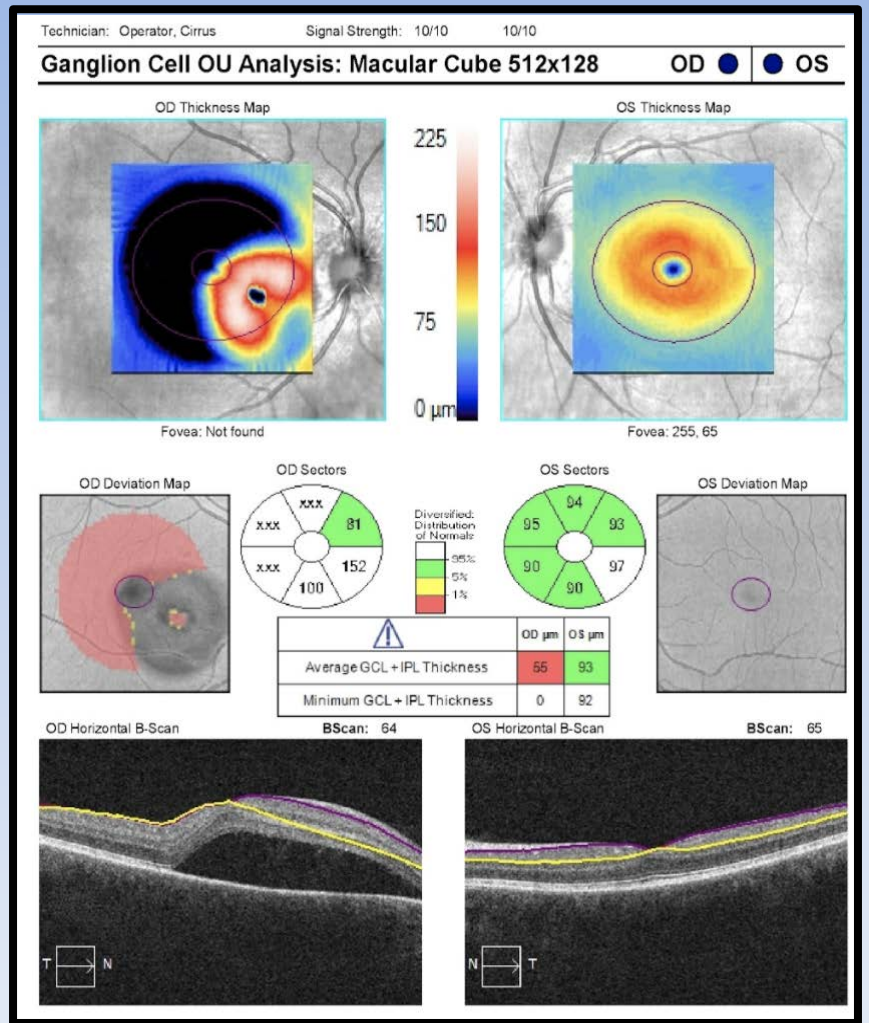
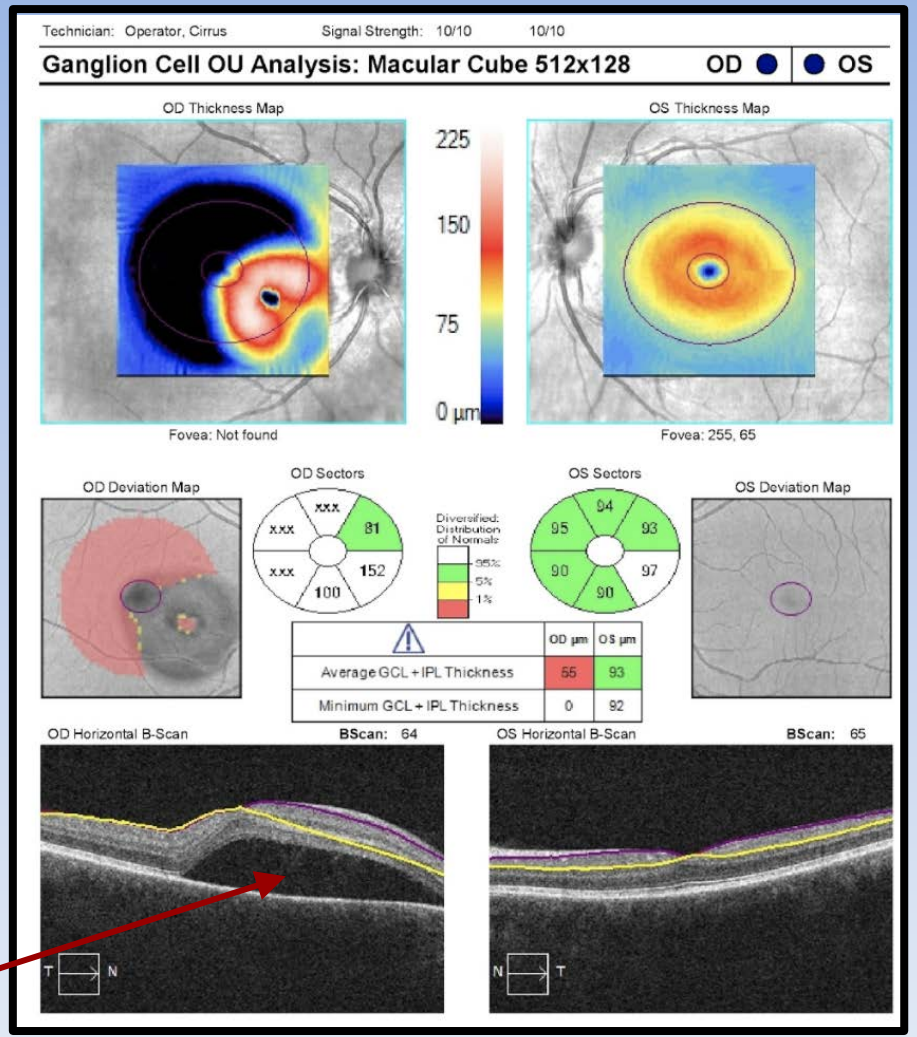


Figure 9. Case 2



Due to the large amount of subretinal fluid seen in the B-scan images, there is an error in segmentation and the GCL-IPL thickness is not reliable

This patient has central serous chorioretinopathy

Subretinal fluid

Figure 10.

Case 3

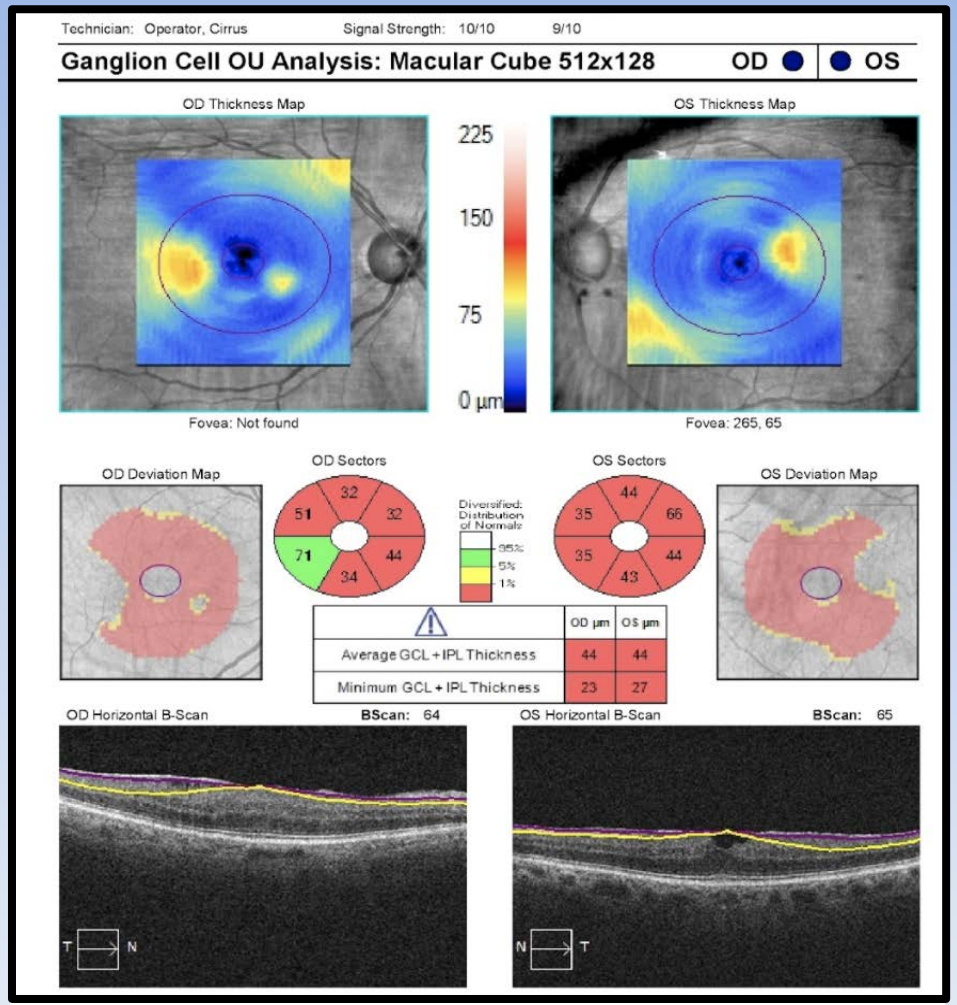


Figure 10. Case 3

Rounded edges on the deviation map suggest that there may be an error in segmentation

This patient has epiretinal membranes in both eyes and there is an error in segmentation. The GCL/RNFL and IPL/INL boundaries are not correctly identified

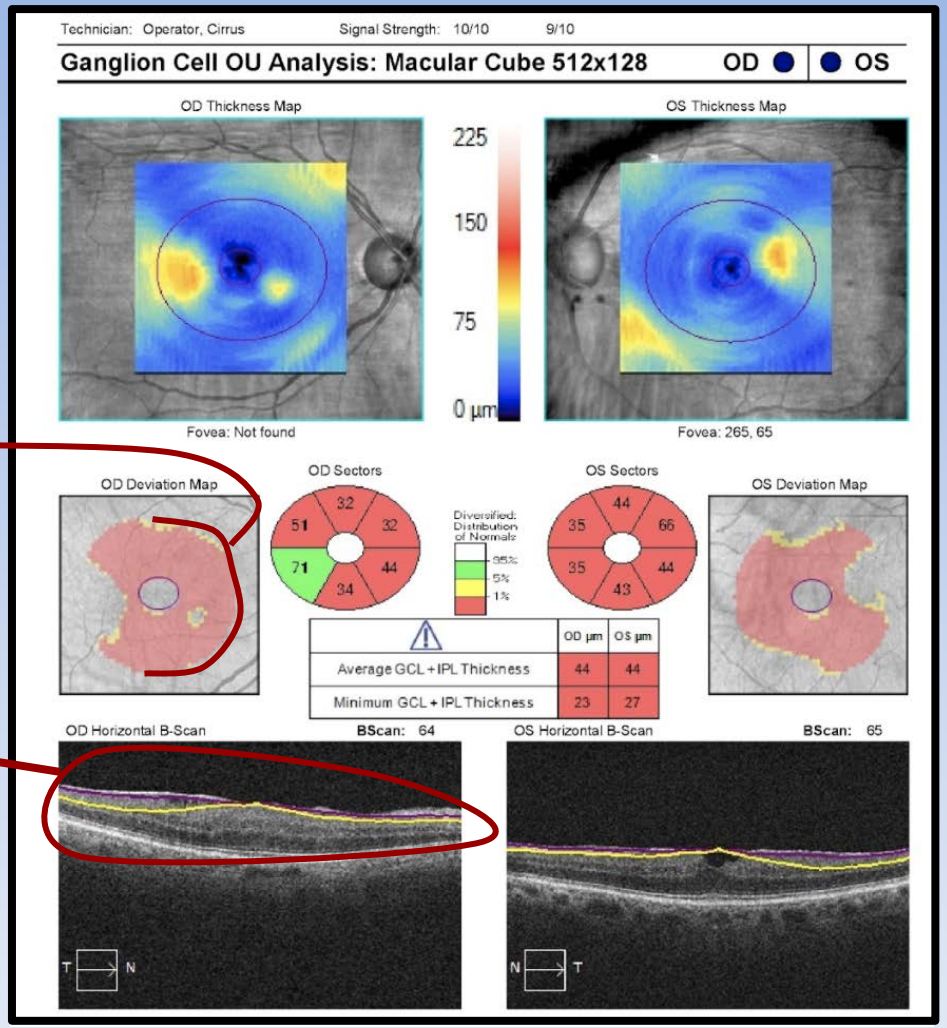


Figure 11. Case 4

Case 4

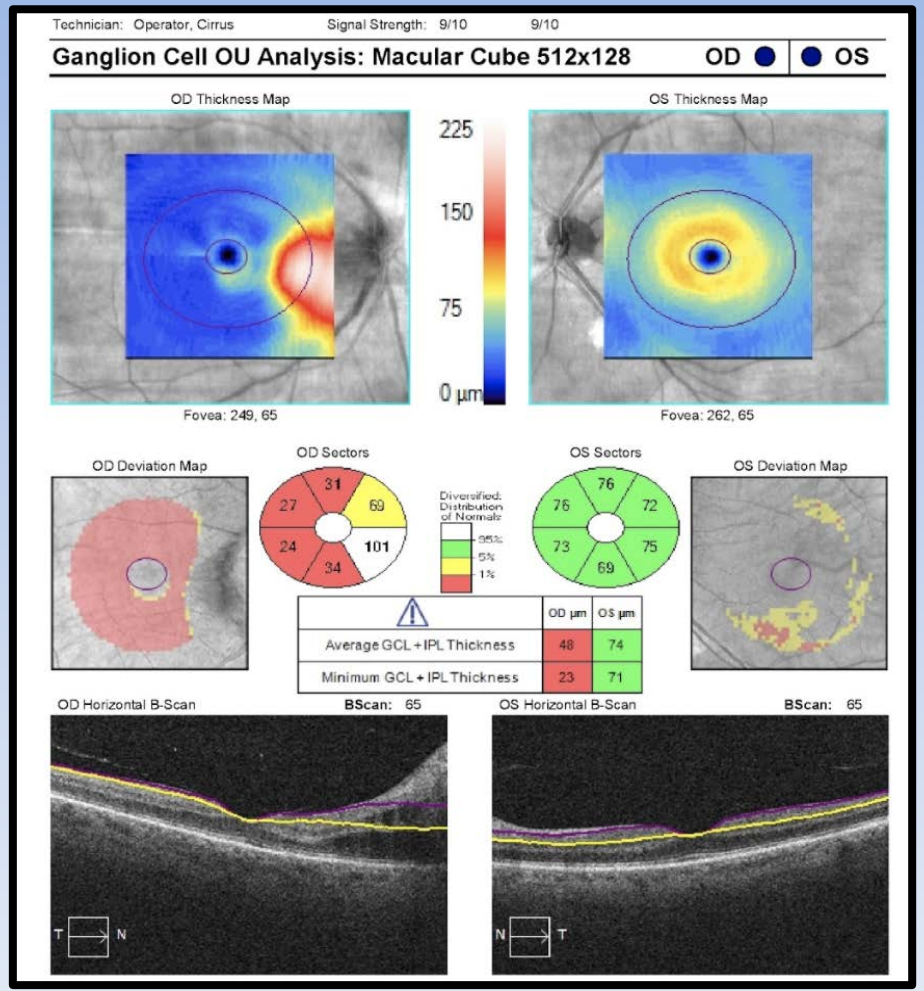
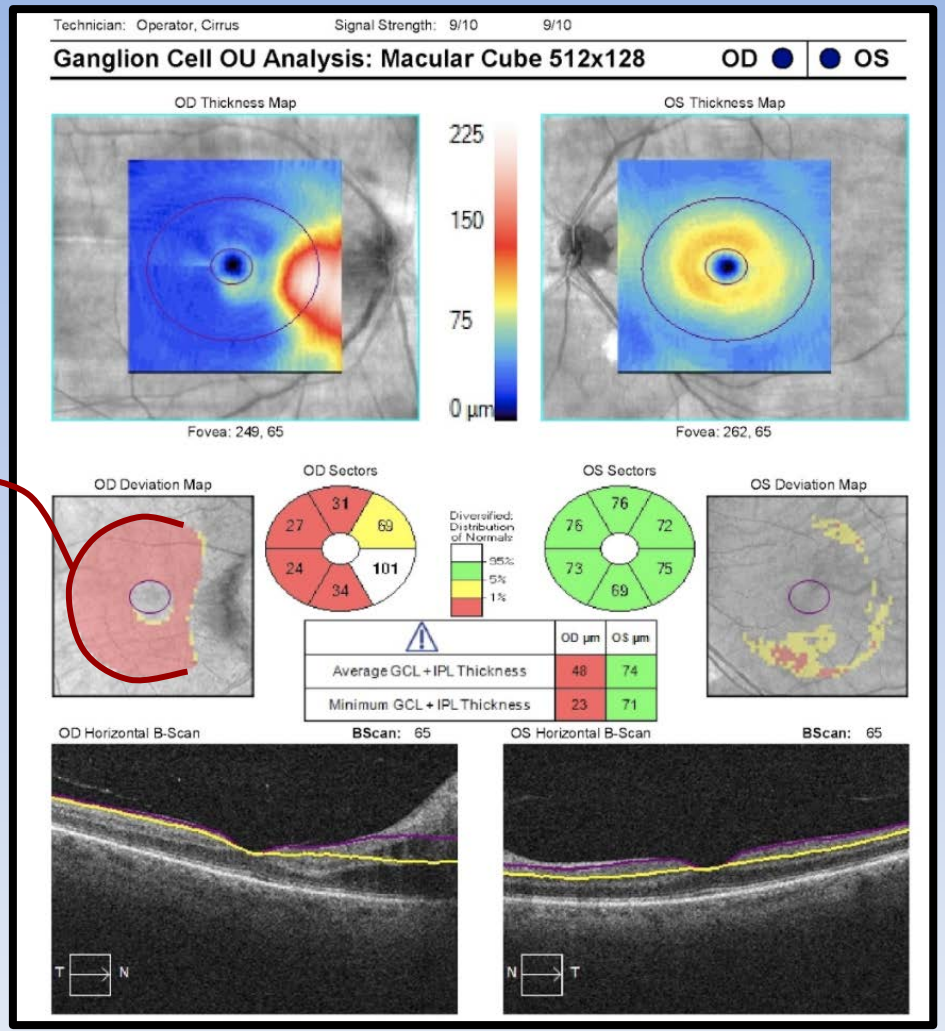


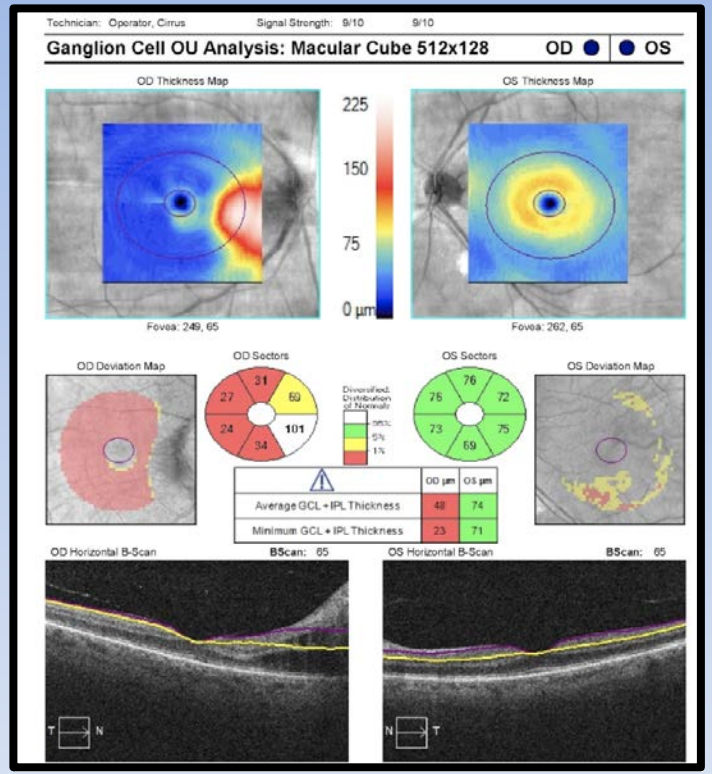
Figure 11. Case 4

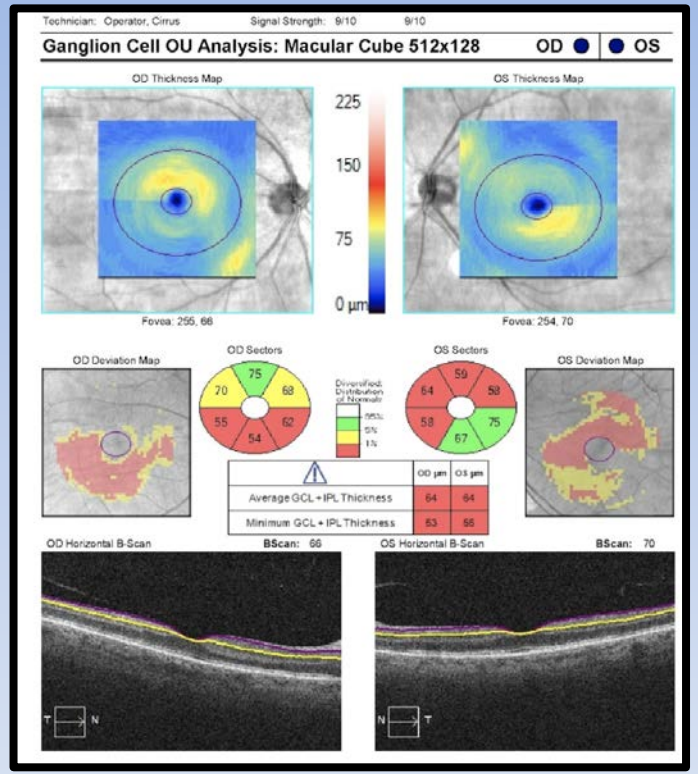


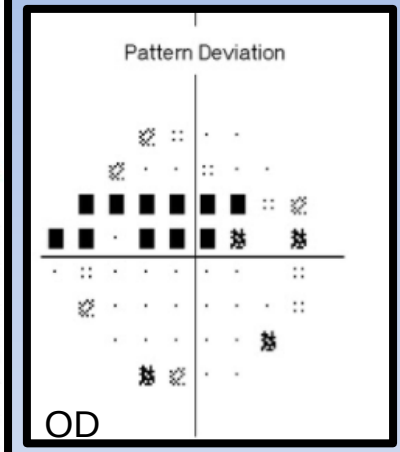
Rounded edges on the deviation map suggest that there may be an error in segmentation

This patient has optic disc edema and there is an error in segmentation. The GCL/RNFL and IPL/INL boundaries are not correctly identified

Figure 11. Case 4



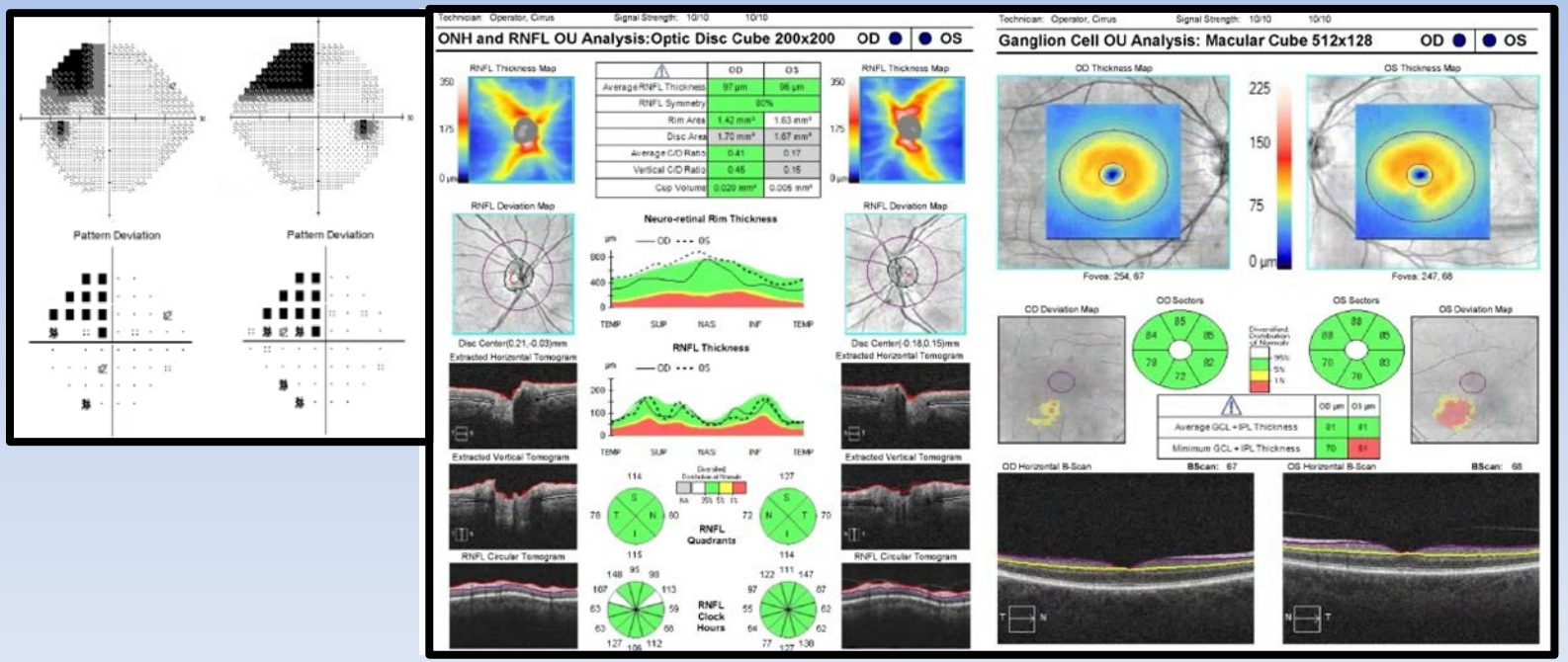




After the optic disc edema resolves, there is correct segmentation and the GCL+IPL thinning inferiorly OD corresponds to the superior visual field defect OD in this patient with non-arteritic anterior ischemic optic neuropathy

OCT of the ganglion cell complex (GCC) vs retinal nerve fiber layer (RNFL)

- Allows easy correlation of visual field defects since it is centered over the macula
- OCT of GCC usually shows loss earlier than RNFL
- GCC not affected by disc edema (assuming correct segmentation) whereas RNFL thickens with disc edema



In this patient with an occipital lobe stroke and retrograde trans-synaptic degeneration, loss of RGCs can be seen with OCT ganglion cell analysis and easily correlated to the visual field defect but not with OCT of the RNFL

Figure 12.

Summary points:

- Optical coherence tomography (OCT) of the ganglion cell complex provides valuable information when evaluating patients with optic neuropathies, chiasmal or retrochiasmal visual field defects

- The ganglion cell analysis has advantages over OCT of the retinal nerve fiber layer (RNFL) since it can be easily correlated with visual field defects and usually shows changes earlier

- The ganglion cell analysis should be interpreted with caution since it is prone to segmentation errors