Ganglion cell analysis by optical coherence tomography (OCT)

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Normal OCT of the macula (cross section through the line indicated on the fundus photo)
Figure 2.

Layers of the retina seen on OCT

- Retinal nerve fiber layer
- Ganglion cell layer
- Inner plexiform layer
- Inner nuclear layer
- Outer plexiform layer
- Outer nuclear layer
- External limiting membrane
- Ellipsoid zone
- Retinal pigment epithelium
- 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)
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.

A single retinal ganglion cell is shown in red.

Figure 4.
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.
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.

**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

Review signal strength
Case 1

Figure 7.
Figure 7.

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

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

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

**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
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 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
Case 2

Figure 9.
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.
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.
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.
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.
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.