Oct in Glaucoma and its Fallacies

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Optical coherence tomography (OCT), first described in 1991, is a noncontact, noninvasive imaging technique that can reveal layers of the retina by looking at the interference patterns of reflected laser light.[1] OCT became widely popular in 2002 with the release of Stratus OCT, a time-domain technology (TD-OCT) that was well-studied and validated for use in glaucoma and retina.

Currently, the most common four commercially available SD-OCT devices in the US are: Cirrus HD-OCT (Carl Zeiss Meditec, Dublin, CA, USA), RTVue-100 (Optovue Inc., Fremont, CA, USA), Spectralis OCT (Heidelberg Engineering, Heidelberg, Germany), and Topcon 3D-OCT 2000 (Topcon Corporation, Tokyo, Japan).[2] Each machine has different glaucoma scan patterns, proprietary software segmentation algorithms, and display outputs, so their measurements are not easily interchangeable.

Use of SD-OCT in Glaucoma :

- Significant structural RNFL loss occurs prior to the development of functional visual field loss. In such pre-perimetric disease, OCT RNFL is especially useful in helping to diagnose glaucoma (nerve fibre thinning) prior to the onset of visual field loss.
- It also has a role in detecting RNFL thinning early disease
- Monitoring glaucoma progression.
- For documentation and as teaching tool for counselling of patient

SD-OCT Parameters :

There are three main parameters relevant to the detection of glaucomatous loss: retinal nerve fiber layer, optic nerve head, and the "ganglion cell complex." Currently the most followed parameter on OCT is parapapillary NFL.[3]

RNFL Thickness :

Retinal nerve fiber layer thickness represents the ganglion cell axons before they enter the optic nerve. The peripapillary RNFL thickness is by far the most popular OCT parameter used for glaucoma diagnosis and monitoring progression.

Various devices measure RNFL thickness in slightly different ways. In the Spectralis OCT, it is measured directly with a 3.46-mm diameter circular scan centered on the optic disc. In the case of the Cirrus OCT, the measurement of RNFL is generated from a 6 mm X 6mm datacube scan centered on the optic disc. The RTVue device scans the optic nerve head with multiple radial and circular scans and generates the RNFL thickness map along a 3.45-mm diameter circle centered on the optic disc.Each of the OCT devices provides the RNFL thickness curve on an age-adjusted normative database where green is considered normal, yellow is borderline and red is abnormal (RNFL values below the 99th percentile of normal database).

As glaucoma advances, RNFL measurement continues to decrease but it doesn't go to zero, which is known as the "floor effect." This is because the architectural support made up by Müller cells, astroglia, microglia and blood vessels doesn't degenerate completely with retinal ganglion cell axons. Once the RNFL thickness reaches the floor, progression can still occur, but it can't be detected by RNFL OCT. So in advanced glaucoma HFA (10-2) is a better device to monitor glaucoma progression.

Sources of Misinterpretation :

1. Signal Quality- When assessing the adequacy of a scan, the signal strength should always be noted. 1 unit of signal strength change can lead to approx. 2 micron decrease in RNFL thickness.[4]

Machine	Minimum acceptable scan quality level
Cirrus SD OCT (Carl Zeiss Meditec)	Signal strengh>6(max 10)
RTVue (Optovue)	Signal strength index≥30 (max 100)
3D OCT (Topcon Medical Systems)	Image quality> 45 (max 160)
Spectralis (Heidelberg Engineering)	Quality > 15 (max 40)

2. **Blink/Saccades :** With eye movement or blinking, the scans do not align correctly which can lead to an erroneous RNFL thickness measurement, which may be misinterpreted as progressive thinning.
3. **Centration** : If the scan is not centered on the optic nerve head, RNFL appears thinner in some sectors and thicker in

others. This may be more common in myopic eyes, which are elongated and often have peripapillary atrophy.

4. **Segmentation Errors :** The OCT machine fails to accurately delineate the layers of the retina. This results in false assessment of RNFL thickness.

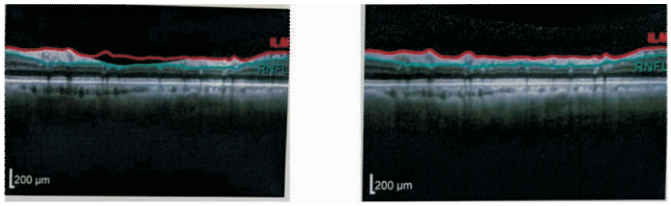

Figure 1 : Segmentation error

5. **Coexisting pathology** : Pathologic changes in the eye can affect RNFL measurements. Media opacities in the form of corneal haze, cataracts and vitreous debris may lead to a false decrease in RNFL thickness, while myelinated RNFL, epiretinal membrane, swelling of ONH and peripapillary retina can falsely increase RNFL measurements.

Macular scan :

Approximately 50% of the retinal ganglion cells reside in the macular region. Imaging the retinal thickness loss in the macula is a sensitive measure for detecting early glaucoma.[5]

Each of the OCT devices provides a different scan of the macula. Cirrus uses ganglion cell inner plexiform layer complex (GC-IPL complex). Optovue uses the GCC that includes the GC-IPL and the nerve fibre layer at the macula. Spectralis uses total macular thickness for macular analysis. The latest software of Spectralis can segment every layer at the macula.[6]

Macular parameters can also be affected by the floor effect, although this occurs later in the disease than is seen in the RNFL because of the high density of retinal ganglion cell in the macular area. So in advanced glaucoma, when RNFL reaches the floor, macular OCT may be more useful. This can also apply to patients with myopia, who have variability in disc morphology and peripapillary atrophy. In both situations, any other pathology affecting the macula should be ruled out before relying on it for monitoring progression.

Optic Nerve Head Scan :

Disc parameters measured by OCT haven't been widely accepted, probably due to variability of disc size, tilt, torsion, peripapillary atrophy and other potential artifacts.

Red disease :

Misinterpretation that occurs when normative database is applied to patients who should not be considered normal (eg. those with high myopia). OCT mistakenly indicates that something is abnormal.

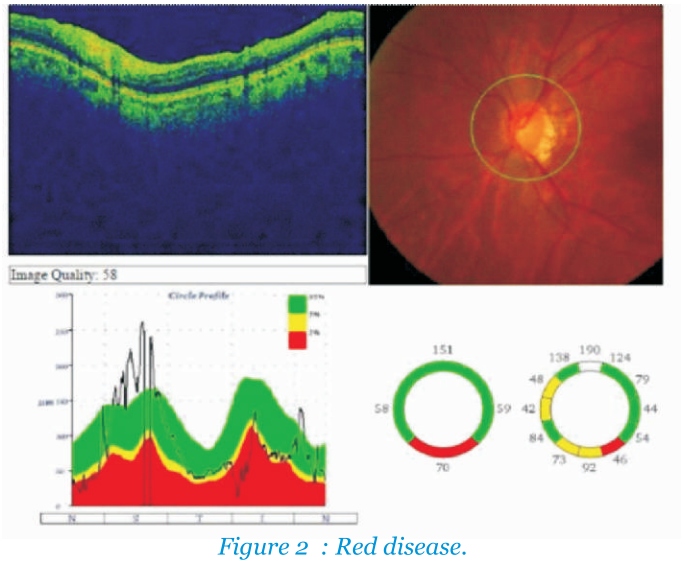

Figure 2 : Red disease.

Green disease : Occurs in patients who have normal global values such as an average RNFL thickness but have small focal defects that are missed. In

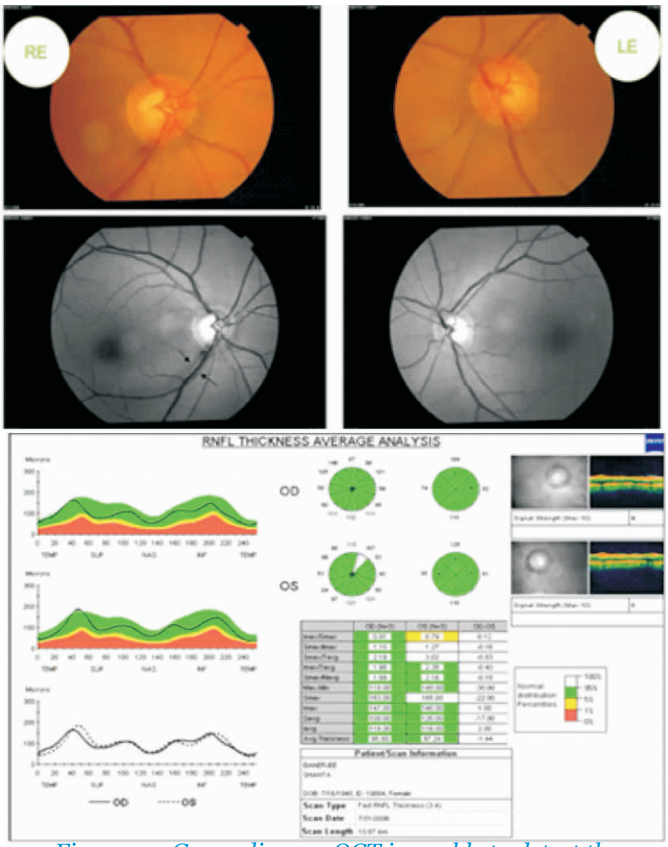

Figure 2 : Green disease. OCT is unable to detect the early inferior RNFL thinning in the right eye

there is inferior RNFL thinning and inferior disc haemorrhage in RE but the OCT RNFL is showing absolutely normal. This is

because unless there is 20-30% RNFL thinning, the OCT RNFL data is still within normative database.

Limitations of OCT :

- OCT machine changes before there is changes in the optic disc. Due to upgradation of software of OCT machine old reports cannot be compared with the recent reports.
- Data from different machines (generations) are not comparable.
- Artefacts are common (20-40%).
- Limited role in myopes, retinal pathology and gross media opacity.
- There is no universally accepted guidelines on OCT progression.

Conclusion :

OCT has proven to be a quantitative and reliable tool for diagnosing pre perimetric glaucoma and monitoring glaucoma progression. However, it should be used in conjunction with clinical evaluation and visual field testing. OCT findings should always be correlated with clinical findings. In early glaucoma, OCT of the RNFL and macula may be important for patients with normal or unreliable visual field tests. In moderate glaucoma, the correlation between OCT measurements and VF tests helps to confirm progression. In advanced glaucoma, one should be aware of the floor effect in RNFL OCT measurements and consider the use of macular OCT and 10-2 visual field tests to detect progression.

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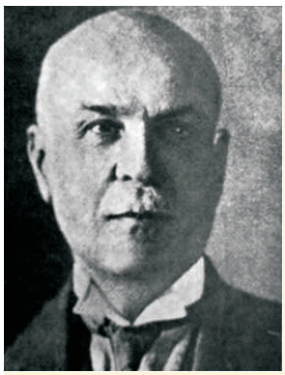

Invention of Gonioscopy by Alexios Trantas

The first person to observe the angle in vivo was the Greek ophthalmologist Alexios Trantas (Figure 1) in 1899 in an eye with kerato globus. He devised a method using direct ophthalmoscopy combined with digital pressure on the limbus. In 1900 he described the ophthalmoscopic appearance of the normal and the abnormal angle and was the first to use the term 'gonioscopy', noting instances of dense pigmentation of the trabecular mesh work, iris processes and cyclodialysis clefts.

Alexios Trantas was born in Epirus, Greece, in 1867 and studied medicine in Athens, where he received his doctorate in 1891, He was also founder and director of the first special pavilion for trachomatous patients in Constantinople, the so-called 'Skouloudeion ophthalmiatreion'. [20] His work covers a wide scope of eye disorders. He wrote mainly about eye symptoms in systemic diseases (leprosy, syphilis, tuberculosis etc.) and recognised the white dots in vernal kerato conjunctivitis as pathognomonic. These small, white-yellow chalky concretions of the conjunctiva around the limbus are known today as the Horner-Trantas spots or Trantas dots Trantas was recognised in 1948 by the Belgian Society of Ophthalmology as the 'Father of Gonioscopy',

Source:

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