Optical Coherence Tomography: Basics & Applied Aspects

Dr.Sujit Deshmukh*, Prof. Shrikant*, Dr. Shraddha Pandey*, Dr. Anushree Agrawal**

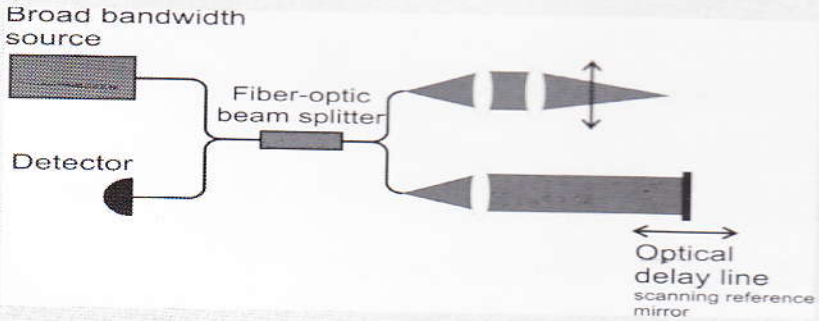
What is OCT?

- It is Live histopathology of retinal tissue.
- It is Diagnostic imaging technique that examines living tissue non-invasively. It is based on a complex analysis of the reflection of low coherence radiation from the tissue under examination.
- It gives Real time cross sectional analysis
- OCT allows both qualitative and quantitative analysis of the retina
- Qualitative analysis includes description by location, a description of form and structure, identification of anomalous structures, and observation of the reflective qualities of the retina.
- Quantitative analysis involves measurements of the retina, specifically retinal thickness and volume, and nerve fiber layer thickness. This is possible because the OCT software is able to identify and "trace" two key layers of the retina, the NFL and RPE.

The OCT system comprises

Fundus viewing unit.
interferometric unit.
Computer display.
Control panel.
Color inkjet printer.

OCT principle



*Dept. of Ophthalmology Institute of Medical Sciences, Banaras Hindu University, Varanasi
**Resident (DNB), Arvind Eye Institute, Pondicherry

Evolution

How does it work?

128 to 768 axial samples (A-scans) in a single "scan pass"
Each A-scan has 1024 data points and is 2mm long (deep).

Resolution

When all of the A-scans are combined into one image, the image has a resolving power of about 10 microns vertically and 20 microns horizontally ,spectral domain has a resolution of 5 microns ,an edge over time domain.

Compare that to the resolution of a good ophthalmic ultrasound at 100 microns

Optical coherence tomography-The process is similar to that of ultrasonography, except that light is used instead of sound waves.

OCT

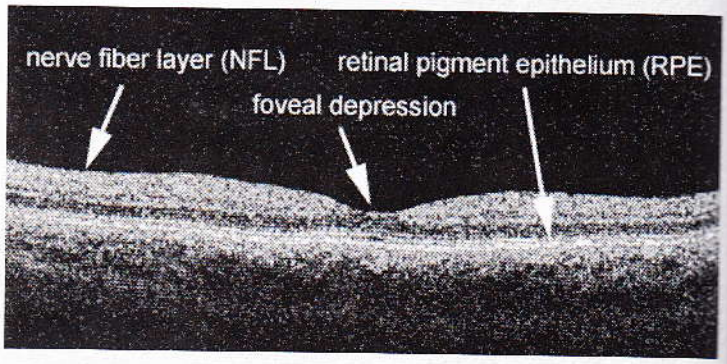
USG

Retinal Anatomy Compared to OCT

The vitreous is the black space on the top of the image

We can identify the fovea by the normal depression

The nerve fiber layer (NFL) and the retinal pigment epithelium (RPE) are easily identifiable layers as they are more highly reflective than the other layers of the retina



This higher reflectivity is represented by the "hotter" colors (red, yellow, orange, white) in the false color representation of the OCT .

The middle layers of the retina, between the NFL and RPE, are much less easily identifiable in the scan.

What makes a good OCT scan?

A good quality OCT scan has good reflectivity from edge to edge.

The "hotter" colors (orange, red, white, yellow) are maximized

Generally, the retina should be in the lower portion of the scan window so that the vitreous can be images as well.

Scanning Tips

Refer to other images of the pathology, e.g. color photos and FA.

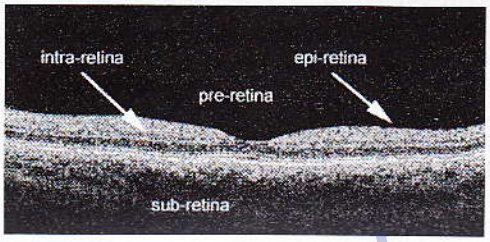
Review past OCT exams and repeat scan types used before.

Dilate the eye well??????

The patient must keep the forehead against the bar and the chin in the chinrest, with teeth together. Use the marker on the headrest to align the patient vertically. The outer canthus should be even with the lineMinimize patient fatigue by keeping scan time to a minimum. Never scan an eye for more than 10 minutes (FDA regulation).

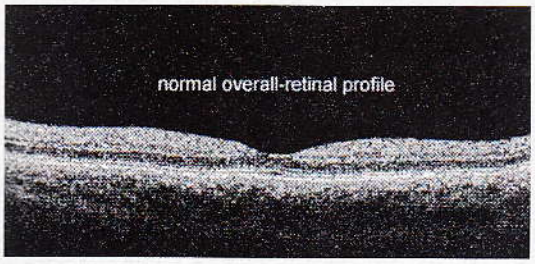
Move the instrument on the x and y axis (using the joystick) to work around opacities

For purposes of analysis, the OCT image of the retina can be subdivided vertically into four regions
the pre-retina
the epi-retina
the intra-retina
the sub-retina



Anomalous structures

- pre-retinal membrane
- epi-retinal membrane
- vitreo-retinal strands
- vitreo-retinal traction
- pre-retinal neovascular membrane
- pre-papillary neovascular membrane



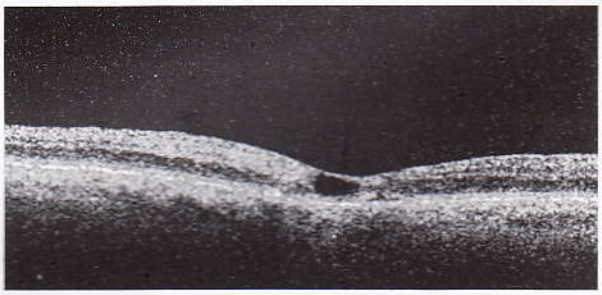
Apre-retinal membrane with traction on the fovea

a pigment epithelial detachment is causing the convexity

Deformations in the foveal profile

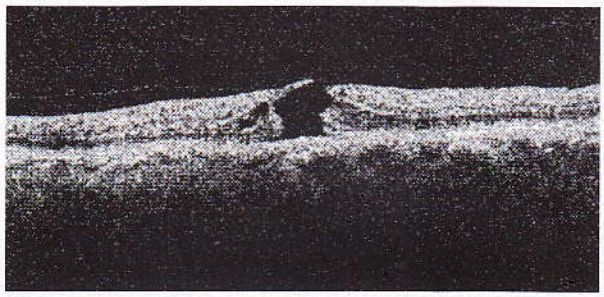
- macular pucker
- macular pseudo-hole
- macular lamellar hole
- macular cyst
- macular hole, stage 1 (no depression, cyst present)
- macular hole, stage 2 (partial rupture of retina, increased thickness)
- macular hole, stage 3 (hole extends to RPE, increased thickness, some fluid)
- macular hole, stage 4 (complete hole, edema at margins, complete PVD)

Macular cyst

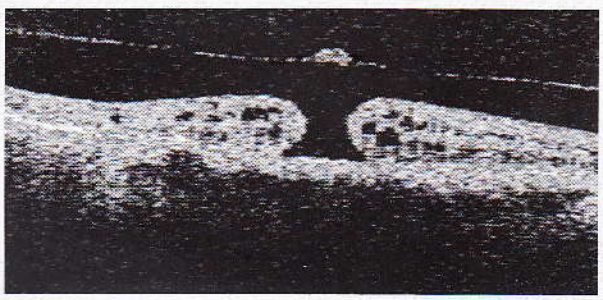


Macular hole, stage 2

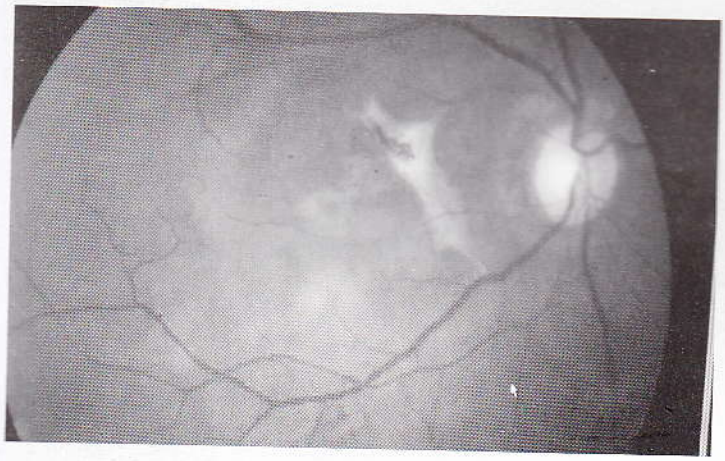
Macular hole, stage 3



Macular hole, stage 4, operculum suspended by the hyaloid membrane

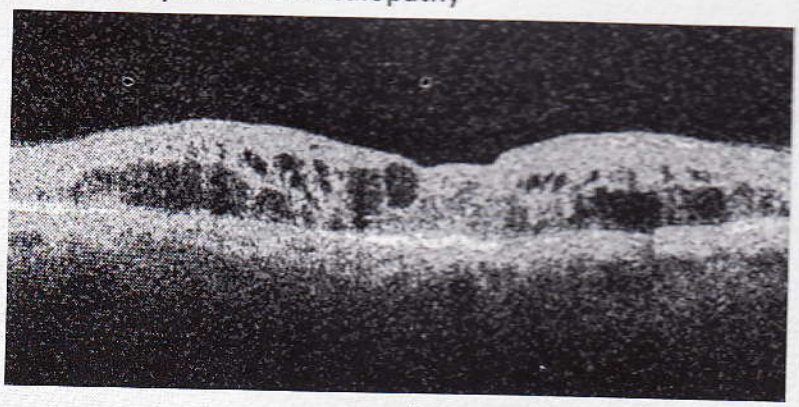


CAN YOU SEE ANY MACULAR HOLE???WAIT....

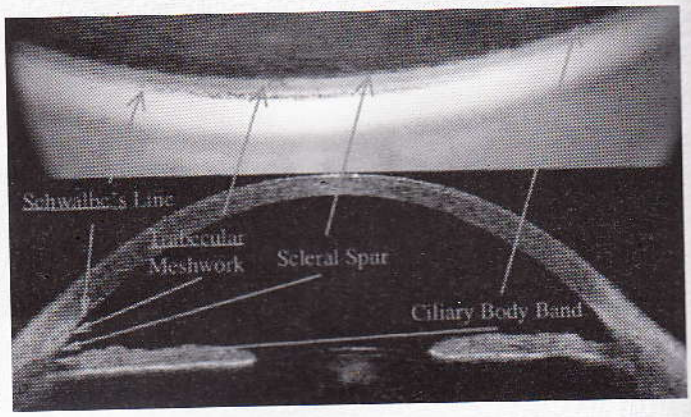


Choroidal neovascular membrane

Cystoid macular edema cause by diabetic maculopathy



Anterior segment optical coherence tomography (OCT)



High-speed anterior segment optical coherence tomography (OCT) offers a non- contact method for high resolution cross- sectional and three-dimensional imaging of the cornea and the anterior segment of the eye.

Anterior Segment Optical Coherence Tomography enhances surgical planning and postoperative care for a variety of anterior segment applications by expertly explaining how abnormalities in the anterior chamber angle, cornea, iris, and lens can be identified and evaluated

Bibliography :

- Hee MR, Puliafito CA, Duker JS, et al. Topography of diabetic macular edema with optical coherence tomography. Ophthalmology 1998;105:360–370.
- Otani T, Kishi S, Maruyama Y. Patterns of diabetic macular edema with optical coherence tomography. Am J Ophthalmol 1999;127:688–693.
- Goebel W, Kretzchmar-Gross T. Retinal thickness in diabetic retinopathy: a study using optical coherence tomography (OCT). Retina 2002;22:759–767.
- Catier A, Tadayoni R, Paques M, et al. Characterization of macular edema from various etiologies by optical coherence tomography. Am J Ophthalmol 2005;140:200–206.
- Diabetic Retinopathy Clinical Research Network. Relationship between optical coherence tomography-measured central retinal thickness and visual acuity in diabetic macular edema. Ophthalmology 2007;114:525–536.
- Drexler W, Sattmann H, Hermann B, et al. Enhanced visualization of macular pathology with the use of ultrahigh-resolution optical coherence tomography. Arch Ophthalmol 2003; 121:695–706.
- Ko TH, Fujimoto JG, Duker JS, et al. Comparison of ultrahigh and standard-resolution optical coherence tomography for imaging macular hole pathology and repair. Ophthalmology 2004;111:2033–2043.
- Hangai M, Ojima Y, Gotoh N, et al. Three-dimensional imaging of macular holes with high-speed optical coherence tomography. Ophthalmology 2007;114:763–773.
- Ojima Y, Hangai M, Sasahara M, et al. Three-dimensional imaging of the foveal photoreceptor layer in central serous chorioretinopathy using high-speed optical coherence tomography. Ophthalmology 2007;114:2197–2207.
- Matsumoto H, Kishi S, Otani T, Sato T. Elongation of photoreceptor outer segment in central serous chorioretinopathy. Am J Ophthalmol 2008;145:162–168.
- Aizawa S, Mitamura Y, Baba T, Hagiwara A, Ogata K, Yamamoto S. Correlation between visual function and photoreceptor inner/outer segment junction in patients with retinitis pigmentosa. Eye 2009;23:304–308.
- Sayanagi K, Ikuno Y, Soga K, Tano Y. Photoreceptor inner and outer segment defects in myopic foveoschisis. Am J Ophthalmol 2008;145:902–908.