Optical Coherence Tomography of Anterior Segment

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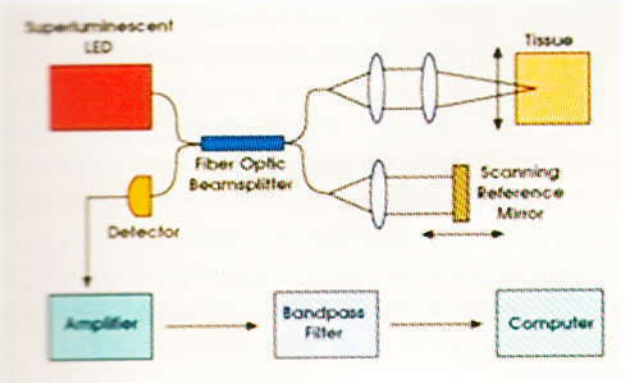
Optical coherence tomography (OCT) is a powerful, non-invasive diagnostic imaging technology that provides high-resolution, cross-sectional images of the eye and other tissues of the body. In ophthalmology, OCT has various clinical applications both in anterior and posterior segment.



Principle of OCT

OCT performs imaging by measuring the echo time delay and magnitude of back reflected light. Conventional or Time-domain OCT, the reference mirror position and delay are mechanically scanned in order to acquire an axial scan (A-scan). In order to get a standard two dimentional cross-sectional image, the beam of light is scanned in the transverse direction and the data is displayed as a false color or grey scale image. A cross-sectional tomograph (B-scan) may be achieved by laterally combining a series of these axial depth scans.

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Recently there have been dramatic advances in OCT technology using spectral / Fourier domain detection that enable imaging speeds of ~25,000 axial scans per second, several times faster than time-domain detection.

Time domain VS Fourier domain OCT

	Time Domain	Fourier Domain
Anterior Segment OCT	Zeiss Visante	Optovue RTVue - CAM
Axial Resolution	17 µm	5 µm
Wavelength	1310 nm	830 nm
Speed	2000 A-scans/sec	26000 A-scans/ sec

Fourier domain OCT usually require an adapter lens to study the cornea. In the cornea, OCT provides an excellent tool for diagnosis and documentation of various corneal pathologies, surgeries and response to therapy.

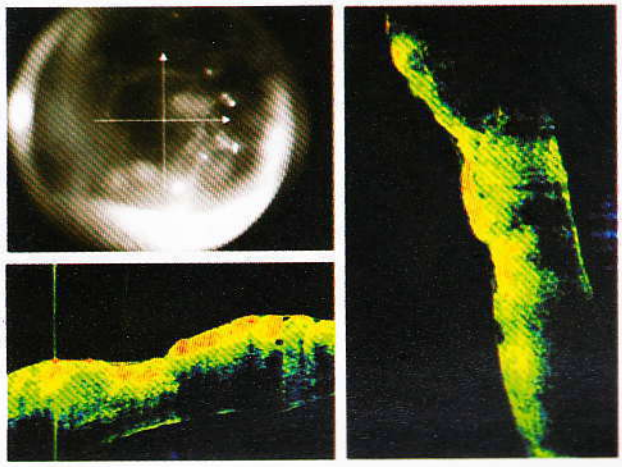
Clinical Applications of OCT:

There are various clinical applications of OCT:

1. Imaging of Cornea:
The OCT provides an high resolution imaging of cornea quite similar as in histopathological sections. One can visualize the various layers of cornea and the pathologies affecting these layers as varying degrees of reflectivity.

2. OCT Pachymetry:
OCT is superior to Orbscan technology which tends to underestimate the corneal thickness in eyes with keratoconus and pachymetry for CCT measurement.

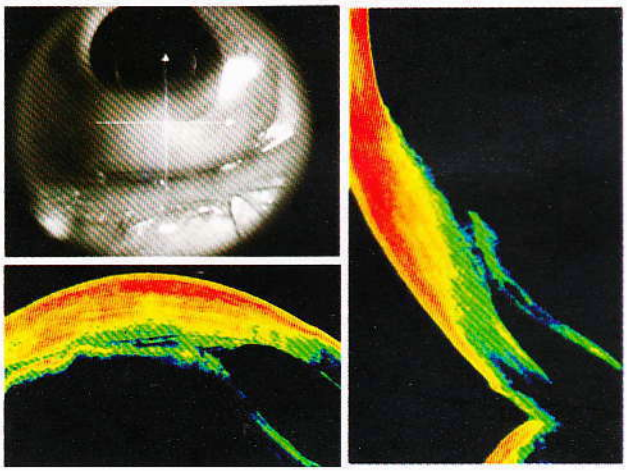
post refractive surgery. Yan Li, Maolong Tang et al[1] used OCT in eyes with keratoconus and finds it equivalent to ultrasound.



OCT picture showing Salzmann Corneal Dystrophy

3. Keratoplasty Surgeries:

As OCT allows the proper visualisation of corneal opacity depth, one can plan whether anterior or deep lamellar keratoplasty is suitable. Laurence S. Lim et al[2] uses OCT prior to DLK and provide very good results in terms of visual outcome.



Descemet's Membrane Detachment

In case, Femtosecond laser is being planned, exact depth of cut can be planned.

Prior to DSEK one can use OCT to clearly visualize the anterior cornea for any opacity which may later on hamper a good visual outcome after endothelial keratoplasty. OCT can be used to detect post-op complications like DMD, lenticule thickness, regularity and interface details which may be difficult to see on slit lamp through an edematous graft.

4. Refractive surgeries:

Prior to Photo Therapeutic Keraoplasty, OCT can be used to precisely measure the opacity depth and the amount of ablation to be done. Post-operatively the quantitative difference in the corneal thickness can be monitored for epithelial hyperplasia and anterior stromal changes. Wirbelauer C et al[3] use corneal OCT before and after PTK for recurrent corneal erosions.

Prior to LASIK corneal OCT helps to assess the suitability i.e. the thickness of the stromal bed and to screen for any other corneal disorder or pathology. Post-operatively OCT allows to measure the flap thickness, regularity, any interfacial deposit or fluid, epithelial in growth etc.

5. Keratoconus diagnosis and treatment:

David Huang et al[4] have demonstrated that OCT can precisely detect the early features of keratoconus. OCT also helps in documentation of progression and changes over time. Effect of procedures like CXL, Intacs etc. can be imaged and documented.

6. Phakic IOL'S:

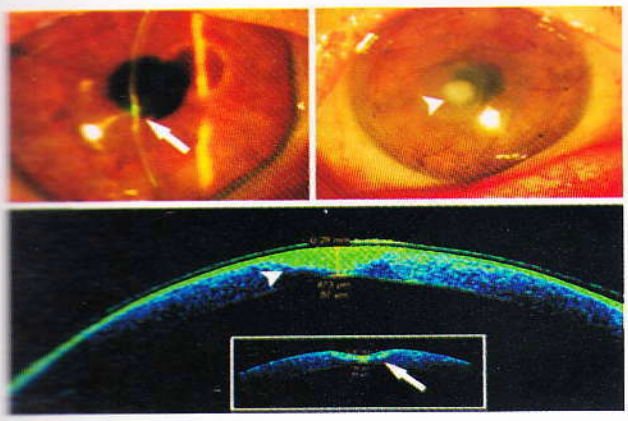
Bechmann Metal[5] described how Fourier domain OCT can precisely measure the anterior chamber depth and provide limbus to limbus imaging in one view, so one can assess the suitability of the eye for phakic IOL. After surgery one can judge the adequate separation of ICL from the crystalline lens.

7. **IOL Power Calculation:**
Minami K et al[5] studied Ray Tracing IOL power calculation using Corneal OCT in eyes that have undergone corneal refractive surgeries and in irregular cornea, as it allows for the presice calculation of the true corneal power.

8. **Dry Eye:**
Brijak MC & Huang D et al[7] studied to measure the tear meniscus height, depth and area by corneal OCT and finds it correlating well with Schirmer's test.

9. **Microbial Keratitis:**
Aris Konstantopoules et al[8] and several others use OCT in imaging of corneal infiltrate density, endothelial plaque, corneal thinning and descemetocoele. Response of therapy can be established by documentation of size & density of the reflectivity of infiltrate.

Mario nubile et al[9] analyze the integration of amniotic membrane transplantation in corneal ulcer in vivo using OCT.



OCT showing integration of amniotic membrane transplantation in corneal ulcer

Conclusion:

OCT is a complete diagnostic tool for any practice. It provides high resolution imaging of the retina, optic disc, cornea and anterior segment. It has multiple uses in corneal evaluation particularly helpful in planning and follow-up after corneal surgical procedures. With the introduction of Fourier-domain technology, the OCT has not only become faster but a more precise imaging tool for the cornea with wide ranging applications in a variety of anterior segment pathologies.

References

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