Clinical Applications of Anterior Segment OCT

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No financial interest

Understanding Anterior Segment OCT

• Anatomy
• Vendors
• Clinical use of AS-OCT
• Technical aspects
• Measurements
• Artifacts
• Recent Cases

What Does Anterior Segment OCT Do?

2-dimensional cross section image of the anterior segment

Anterior Segment Anatomy

Corneal Anatomy

Cornea

Iris / Angle

Lens

Conjunctiva / Sclera

Anterior Chamber IOL

Slipped Lens

Capsular Block

Closure Angle

Conjunctival Lesion

Sclera Buckle

Pterygium

Scleral Keratopathy

DSEK with fold

High Pressure

Gonioscopy

Closed Angle

Keraconus

Bullous Keratopathy

Hydrops

DSEK with fold

Epithelium

Tear Film

Air / Tear interface

Stroma

Endothelium

Air / Tear interface

Lens

Anterior Chamber F/4

Capsular Buckle

Slipped Lens

Capsular Tears

Conjunctival Lesion

Sclera Buckle
### Anterior Segment OCT Vendors

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioptigen</td>
<td>Handheld OCT</td>
</tr>
<tr>
<td>Heidelberg</td>
<td>Spectralis with Lens</td>
</tr>
<tr>
<td>Optos</td>
<td>Optos OCT/SLO</td>
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<tr>
<td>Optovue</td>
<td>RT-Vue with CAM</td>
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<tr>
<td>iVue</td>
<td></td>
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<tr>
<td>Topcon</td>
<td>SL Scan-1</td>
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<tr>
<td></td>
<td>3D OCT-2000</td>
</tr>
<tr>
<td>Zeiss</td>
<td>Visante and Cirrus</td>
</tr>
</tbody>
</table>

*Courtesy of John Cooper,*

*Courtesy of Sunita Sayeram and Joseph Vance,*

*Courtesy of Tim Steffens,*

*Courtesy of Optos,*

*Courtesy of Optovue,*

*Courtesy of Bruno Bertoni, CRA, OCT-C and Tamera Schoenholz, CRA,*

*Corneal Scar Courtesy Team Doheny Eye,*

*AC Tube Courtesy Ellen Redenbo and Mark Thomas,*

*Synechia Courtesy Team Doheny Eye,*

*K-Pro Courtesy Mark Thomas and Ellen Redenbo,*

*Photo Credit: Media Resources Centre University Hospital of Wales Caerphilly UK*
Cirrus

Internal Optics
Software Upgrade needed
Two scan patterns
5-line raster 3 mm length, adjustable rotation and spacing
512x128 cube scan.

Images courtesy of Martha Leen, M.D. & Paul Kremer M.D. Achieve Eye and Laser Specialists, Silverdale, WA

Closed Angle Glaucoma
Filtering Bleb
DSEK
Fuchs’ Dystrophy

Are you getting reimbursed for your AS-OCT?

Billing
- 0187-T: Temporary Code, Medicare reimbursement varied according to Medicare regions
- 92132: AMA established CPT code, Medicare covers this code. Some states may have a Local Medical Review Policy (LMRP) where only specific diagnoses are covered.
- SCANNING COMPUTERIZED OPHTHALMIC DIAGNOSTIC IMAGING, ANTERIOR SEGMENT, WITH INTERPRETATION AND REPORT, BILATERAL

1 Week After Phaco and 1-Piece Posterior Chamber IOL
Dislocated IOL
IOL in the Capsular Bag

Tecnis One-Piece

Causes of the Dislocted IOL
- IOL not in capsular bag but in ciliary sulcus
- Ruptured zonules
- Hole in posterior capsule
- Broken haptic
- Crimped haptic

Relationship Between the IOL and the Capsular Bag?
- How can I obtain a 2-dimensional cross-sectional image of the anterior segment of the eye?
  - Anterior segment OCT
  - Immersion B-scan ultrasound

Ultrasound Biomicroscopy (UBM)
- 2-dimensional cross-sectional image of anterior segment
- Multiple meridians
Dislocated IOL UBM

- IOL optic
- IOL haptic in position

Dislocated IOL UBM

- IOL haptic truncated

OCT Versus UBM

- 2-dimensional cross-sectional images of anterior segment
- Multiple meridians
- OCT provides more fine detail and magnified image
- OCT non-contact versus UBM contact (water-bath)
- OCT more useful to the anterior segment surgeon because easy to use

OCT Versus UBM

- MD or photographer performs UBM
- Photographer performs OCT
- OCT and UBM require communication between MD and photographer

Anatomic structure(s)

- Location
- Magnification
- Imaging protocol

OCT Specifications Comparison

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>Domain</th>
<th>Scans/sec</th>
<th>Res Axial (μm)</th>
<th>Res Trans (μm)</th>
<th>Scan Depth (μm)</th>
<th>Scan Length (mm)</th>
<th>Lens Magnification</th>
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<tr>
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<td>Visante Time</td>
<td>Time</td>
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<td>18</td>
<td>60</td>
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<td>16mm</td>
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</tbody>
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Notes: Oort, Spectral, and Topcon (as of March 2012)
Anterior Segment Specifications

Specifications | Visante | Spectral
--- | --- | ---
Wavelength | 840-870 | 1310
Optical Power | < 6500 µW | < 750 µW

The longer wavelength of light and stronger optical power allow TD technology to penetrate deeper into the angle. The shorter wavelength of light and lower optical power make it possible for the SD technology to also image the retina.

Scan Depth: 3mm, 6mm
Scan Length: 10mm, 16mm

Higher wavelength allows for deeper scan depth and longer scan length. Longer scan length can image limbus to limbus. *Heidelberg is exception

The following two slides show one individual wearing a +13.50 soft contact lens.

Importance of Scan Length

- **DSEK**
  - Limbus to Limbus Imaging is necessary to ensure proper attachment of the donor tissue
- **Scleral Contact Lens Fitting**
  - Needed to view the entire lens in one image
- **Glaucoma**
  - Able to measure both angles from one image.
Why Do I Image the Cornea?

- Analysis of new corneal transplantation techniques
- Management of postop complications
- Document healing of surgical incisions
- Plan operations
- Management of corneal ulcers
- Evaluate extent of tumors of the ocular surface
- Measurements of the anterior segment

Fuchs’ Corneal Dystrophy

- Fuchs dystrophy
  - Inherited disease of corneal endothelium
  - Endothelium dysfunctional
- Corneal edema
- Vision decreases
- Guttae obscure endothelium
  - Specular microscopy

Fuchs’ Dystrophy Function

- Pumps H₂O out of the cornea into the anterior chamber
- Keeps corneal stroma at 78% H₂O
- Transparent at thickness 550 μ
- Pachymetry is a measurement of corneal thickness
- Gauges health of cornea

Corneal Edema

- Hazy cornea
- Stomal and epithelial edema

Fuchs’ Dystrophy Treatment

- Penetrating keratoplasty
  - Full thickness recipient cornea removed
  - Full thickness donor cornea sutured into place
  - 360° full thickness corneal wound
  - 1 year for visual rehabilitation
  - Irregular healing of wound results in variable visual results due to astigmatism

Penetrating Keratoplasty

- Epithelial defect

Penetrating Keratoplasty

- Irregular healing of full thickness incision
  - Visually disabling astigmatism

DSEK: Descemet’s Stripping Endothelial Keratoplasty

- Diseased endothelium and Descemēt’s membrane removed (30 μ)
- Donor endothelium and stroma inserted (~150 μ)
- Small incision (5 mm)
- Rapid healing and visual rehabilitation in 30 to 60 days

OCT to Monitor Health of DSEK

- Position
- Attachment of graft to recipient
- Quality of interface
- Corneal thickness
DSEK

DSEK 4 Weeks Post-op

Ultrasound Pachymetry Incorrect
- Normal thickness 550 μ
- 30 μ endothelium and Descemet’s membrane removed
- 180 μ donor cornea implanted
- Pachymetry after DSEK should be at least 700 μ

DSEK 4 Weeks Postop

Visante Flap Tool

Anterior Segment OCT
- DSEK attachment 360° would indicate primary donor failure
  Require graft replacement
- DSEK detachment
  Reattach graft with air

Detached DSEK 1 Day Postop

DSEK Reattachment
Air Injection

1 day postop
1 week postop
7 weeks postop
4.5 months postop

Malpositioned DSEK
Malpositioned DSEK

Available Measurements
- Corneal thickness
- Anterior chamber depth
- Anterior chamber angle
- Incision
- Tumor

Automated Global Pachymetry

Corneal Thickness

Corneal thickness 769 μ

Pachymetry Data Points

Anterior Chamber Depth

Measuring Angles
Measuring Angles

- AOD: angle-opening distance
- TIA: trabecular-iris angle
- TISA: trabecular-iris space area

Clear Corneal Incision

Tumors / Cysts

Artifacts

- Corneal Reflex
- Inverted Image (in Spectral Domain)
- Shadowing
- Image Averaging
- Algorithm Failure
  - Pachymetry: Corneal surface lines
  - Pachymetry: Lids

Corneal Reflex

Inverted Image

Spectral Domain

Shadowing?
Shadowing

Image Averaging

Top: Non-averaged Scans
Bottom: Averaged Scans

Averaging

Enhanced High Res Cornea Mode

Measuring with Averaging

Enhanced High Res Cornea Mode

Dewarping

Enhanced Mode

Algorithm Failure Due to Lids

Algorithm Failure Due to Corneal Surface Lines
Algorithm Failure
Due to Corneal Surface Lines

How Else Does Anterior Segment OCT Help Me With Patients?

Visualize Depth of Corneal Scar

Visualize Depth of Corneal Scar
- Flattening of corneal surface over scar

Ocular Surface Tumors
- Does the tumor extend into the cornea, sclera, and anterior chamber angle?
- Plan operative procedure

Corneal and Conjunctival Intraepithelial Neoplasia

Infectious Keratitis
- Hazy cornea
- Difficult to see extent of corneal involvement
- Monitor response to medical therapy
Fungal Corneal Ulcer

Anterior Chamber Depth
- Important for IOL calculation
- Theoretical prediction formula: Haigis
- Required to predict the post-op position of the IOL
- Correct IOL power can be inserted
- 0.05 mm ACD error = 0.03 dioptr IOL power error

Pre-op Phaco IOL Calculation
Anterior Chamber Depth

Irregular Pupil

Gonioscopy
- Peripheral anterior synechiae
- Holes in iris

Essential Iris Atrophy

Interesting Recent Cases
- 1 day postop
- Localized corneal edema at incision

Anterior Segment OCT
Detached Descemet’s Membrane

923 µ
2 Months Postop
Irregular Posterior Cornea

2 Months Postop
Endothelial Gape

1 Day Postop DSEK
Corneal Edema

Can you tell if the DSEK is attached??

Anterior Segment OCT
DSEK Not Attached

2 Days After Air Injection

Anterior Segment OCT
Visante

Anterior Segment OCT
Heidelberg

Fuchs’ Dystrophy
Heidelberg

21 Months Postop DSEK
Visante vs Heidelberg
21 Months Postop DSEK
Heidelberg

Avoid the corneal reflex
Operable in interface

Corneal Edema with Hydration
Etiology and Management?

Pellucid Marginal Corneal Degeneration

Keratoconus

Thanks for your help!

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Graham Lyles, MD
Isaac Porter, MD
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