Optical Coherence Tomography & Ultrasound Biomicroscopy of the Eye

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Two New Imaging Modalities

- Optical Coherence Tomography (OCT)

- Ultrasound Biomicroscopy (UBM)
Optical Coherence Tomography (OCT)

- Introduced in 1991 by NEEC & MIT
- Analogous to ultrasound imaging
- Uses near infrared laser instead of sound waves
- Characterizes scatter variation
OCT Histopathologic Correlation

NYEEI, Ocular Imaging Center
Advantages of OCT

• Non-invasive
• Non-contact
• Minimal cooperation needed
• Resolution $\sim 10 \, \mu m$ (vs. US=150 $\mu m$; UBM=50 $\mu m$)
• Pick up earliest signs of disease
• Quantitatively monitor disease/staging
Disadvantages of OCT

- Best for optically transparent tissues
- Diminished penetration through retinal/subretinal hemorrhage
- Requires pupil diameter $> 4$ mm
Sample Applications

• Macular holes (partial/complete absence of retinal tissue)
• Retinal pigment epithelial detachment
• Diabetic retinopathy and macular edema
• Central serous chorioretinopathy
• Age-related macular degeneration
• Epiretinal membranes
OCT - Normal Fovea

Visible Structures

- Foveal depression
- Retinal Nerve Fiber Layer (RNFL)
- Photoreceptor Layer (PRL)
- Retinal Pigment Epithelium (RPE)
- Choroid
OCT - Macular Hole

DDx of Macular Hole

- Lamellar hole
- Macular cyst
- Epiretinal membrane with pseudohole
- Foveal detachment due to central serous retinopathy
- Vitreomacular traction syndrome
Alternative Tests - Macular Hole

- Slit-lamp biomicroscopy – meticulous, qualitative, low reproducibility
- CT & MR imaging - limited resolution
- Conventional ultrasound - resolution of only 150 μm
- UBM - limited to anterior segment
- Indirect ophthalmoscopy
- Floresecein angiography
Macular Hole After Surgery

SUCCESSFUL REPAIR (PRE-OP)

SUCCESSFUL CLOSURE (POST-OP)

RNFL
PRL
RPE
CHOROID

SIDES: WHITE LINES
BASE: DOTTED LINE

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Nonproliferative Diabetic Retinopathy and Macular Edema

- Foveal thickness correlated with visual acuity
- Edematous neurosensory retina
- Diminished reflectivity
Alternative Tests - Diabetic Retinopathy

- Florescein angiography
  - gold standard
  - minimally invasive
  - qualitative detection
  - low reproducibility
  - leakage not correlated with visual function
Retinal Pigment Epithelial Detachment

- Fluid between RPE and choroid
Central Serous Chorioretinopathy

- Fluid between RPE and PRL
Two New Imaging Modalities

- Optical Coherence Tomography (OCT)
- Ultrasound Biomicroscopy (UBM)
Ultrasound Biomicroscopy (UBM)

• Introduced in 1990 by Princess Margaret Hospital, Canada
• Similar to conventional ultrasound imaging
• Uses high frequency ultrasound transducers 50 MHz (vs US 10 MHz)
• Patient in supine position with topical anesthesia
• 20 mm eye cup between eyelids filled with saline
• Probe placed into eye cup
Advantages of UBM

• Resolution of $\sim 50 \, \mu m$ (vs US=150 $\mu m$)
• Anterior segment of the eye
• Not limited to optically transparent tissues (i.e. opaque corneas)
Disadvantages of UBM

• Direct contact
• Penetration of only 4-5 mm
• Image influenced by
  – Plane of section
  – Distance to anterior chamber
  – Orientation of the probe
  – Room illumination
  – Fixation
  – Accommodative effort
Sample Applications

• Pupillary block angle-closure glaucoma
• Ciliary body tumors
• Ocular trauma
• Pigment dispersion syndrome & pigmentary glaucoma
• Intraocular lens position
• Failing filtering blebs
Normal Eye

- Aqueous humor flows through pupil and into Canal of Schlemm
Normal Eye Using UBM

Visible Structures
• Cornea
• Sclera & scleral spur
• Ciliary body
• Schwalbe’s line (end of Descemet’s membrane)
• Anterior chamber & angle
• Iris
• Posterior chamber
• Anterior lens capsule
Pupillary Block Angle-Closure Glaucoma

- Most common angle-closure glaucoma
- Mechanism
  - Aqueous made in posterior chamber unable to pass through pupil
  - Pressure gradient develops behind iris
  - Pushes iris against trabecular meshwork
- Treatment: laser iridotomy (tiny hole at side of iris)
Ciliary Body Tumors

- Can cause angle-closure
- Uneven acoustic echoes
Ocular Trauma – Angle Recession

- Tear into ciliary body
- Iris insertion appears posterior
Image References

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- Normal Eye using UBM
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- Ciliary Body Tumors
- Ocular Trauma – Angle Recession

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Core Radiology/September 18, 2000
HMS III