Adaptive Optics
Ophthalmoscopy: Results and Applications

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Wavefront Congress
Images of a Point Source vs Pupil Diameter
Adaptive Optics Principle

Deformable Mirror

Wavefront Sensor

Imaging Camera
High Resolution Retinal Images

Heidi Hofer and Matt McMahon
Triangular mosaic that is fairly regular
\[ r = \sqrt{3}/2 \times \text{center-to-center spacing} \]
Trichromatic Cone Mosaic

Average L:M = 2:1

Roorda & Williams, 1999
Alternate Cause of Color Blindness

Red-Green Dichromacy

Carroll et al 2004
Alternate Cause of Color Blindness

Complete loss of M cones

Replacement of L cones
Cone Directionality

\[ n_1 > n_2, \quad n_2 > n_3, \quad n_1 > n_2, \quad n_2 > n_3 \]

Reflected

Refracted
Cone Directionality

Registered sum of 8 images along 9 different positions

1° eccentricity

5 arcmin
Cone Directionality

Roorda and Williams 2002
Imaging of AMD with Adaptive Optics

Drusen displaces the RPE and results in loss of pigments.

Without AO  With AO

Stacey Choi
Changes in cone reflectance over time

Pallikaris A et al 2003
Disc Shedding of Extrafoveal Human Cones

A, B. Electron micrograph of two cones and their associated RPE apical processes
C. Phagosome surrounded by RPE apical processes
D, E. Cone outer segment tip

R. H. Steinberg et al.
Confocal Scanning Laser Tomography
Live AO Correction

KV OS

Automatic AO at Fovea

AOSLO Houston 06/06/2002

1.5 deg

KV left eye, fovea
registered photoreceptor images from AOSLO
Direct Visualization of Leukocytes

- No fluorescent dyes required
- Identify ghost vessels (non-perfused capillaries)
- 95% confident of velocity changes as small as 0.076 mm/sec

Slide Courtesy A. Roorda

Martin J., Roorda, A. IOVS under revision
Diabetic Retinopathy

Earliest structural changes are found in the retinal capillaries
Glaucoma

Optic Disk for an Eye with Glaucoma.

Optic Disk for Normal Eye.

Early detection and treatment can control glaucoma and prevent further damage.
Imaging glaucoma in a monkey model

Slide Courtesy A. Roorda

Lamina Cribrosa

1 degree

Abhiram Vilupuru, Nalini Rangaswamy, Laura Frishman, Ron Harwerth
Imaging glaucoma in a monkey model

Slide Courtesy A. Roorda

Abhiram Vilupuru, Laura Frishman, Ron Harwerth
• Increase of the transverse resolution to 5-10 μm
• Signal to noise ratio increase by up to 9 dB

B. Hermann et al 2004
Discussion

• Adaptive optics ophthalmoscopy allow the microscopical view of the retina

• Adaptive optics ophthalmoscopy may be used both for basic science and clinical applications

• Further improvement of adaptive optics system along with the combination of other retinal imaging enhancing methods could enable three-dimensional visualization of photoreceptors, ganglion cells or RPE cells.
Acknowledge

Austin Roorda and Colleagues
David R. Williams and Colleagues

Thank you
Summer School
20– 26 June (Part I)
27 June –1 July (Part II)

Aegean Retina
1 – 3 July 2005

www.EyeInstituteCrete.com