Ocular Anatomy, Embryology, Clinical Evaluation & Imaging

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What to Take From the Lecture

• 2 types of people:
  – Those focusing on ocular disease
  – Those who happen to notice something funky with their model’s eye(s) (e.g. ?cloudy cornea; ?cataract; not there!)

• Aims:
  – Notice something wrong with your model:
    • How to investigate without killing it (in-vivo)
    • How to further investigate in detail post-sacrifice (ex-vivo)
  – Genetic & Environmental/inducible eye disease models:
    Whole Globe, Cornea, Glaucoma, Lens, Retina, Neoplasia
  – Specific considerations in animal ocular phenotyping
  – Eye problems confounding your studies (e.g. behavioral tests)
  – Hopkins investigators in specific eye research areas
Animal Eye Anatomy (Human & Mouse)

- Newborn’s eye: about 18mm axial length
- Infant’s eye: 19.5mm axial length
- Adult human’s eye: 24-25mm (approx. 1inch)
- Mouse eye: 3-3.5mm
Eye Embryology

- Surface Ectoderm: Corneal epithelium; Lens
- Neural Tube: Retina; Iris epithelium & muscles, Ciliary body epithelium
- Mesoderm: everything else
Animal Clinical Eye Evaluation

External Visualisation

Retinoscopy

Monocular (center bridge)

Binocular (center to center)

Exophthalmometry
Telorism: Cranio-Facial Structure
Exophthalmos / Proptosis (Posterior to Eye)
Slit Lamp Examination
Cornea: Some Animal Phenotypes

- Optical (e.g. opacity) vs physical (e.g. thickness, curvature) issues
- Corneal curvature: infrared photokeratometry
- Corneal thickness: pachymetry
Lens: Genetic Models

• Most genetic mouse cataracts congenital (humans: age-related)
• Understanding of lens development rather than ageing
• Many mouse models:
  – Most commonly
    Gamma-crystallins (Cryg)
  – Some postnatal, progressive
    Beta-crystallins (Cryb)
  – Membrane proteins
    MIP or connexins
  – Transcription factors
    FoxE3, Maf, Sox1, Six5
  – Systemic disease models:
    Galactosemia, SDH, perlecan
• **Beware:** Anesthetic-induced-induced
Animal Clinical Eye Evaluation

Indirect Ophthalmoscopy

- Large Field
- Depth of focus
- Stereopsis
- Use with scleral indentor
- But hard to get used to!

Coaxial Light Microscope
Ultrasound (A,B,M)
Whole Globe: Genetic Models

- Anophthalmos
- Microphthalmos
- Buphthalmos (whole eye)
- Axial myopia (single axis)
  - Zenk/Egr mouse
  - Marfan mice
  - Collagen 8 mutants
  - Lumican/fibromodulin
Axial Myopia: Genetic Models: Marfan

- Cornea
- Pupil
- Iris
- Aqueous Humor
- Lens
- Choroid
- Retina
- Optic Nerve
- Vitreous Humor
Magnetic Resonance Imaging (MRI)
Refraction: Zeiss IOL & AC Master
Refractive Error: Streak Retinoscopy

- Considerations:
  - Do I need to dilate?
  - Do I need to cyclopleg?
  - Different agents...
  - Varying strength, effect in mice, duration etc.
  - 2 eyes in same mouse can vary considerably
Visual Field Testing
Intraocular Pressure (IOP): Tonometry
IOP Measurement in Mice

- AC needle vs tonolab
- Anesthetics affect IOP (inhalational)
- Hold mouse too tight affects IOP
- Corneal issues affect Tonolab
Retinal Analysis

- Retinal Imaging Microscopy System allows ‘in-vivo microscopy’
- White light imaging mice and rats, fluorescein angiography, diabetic retinopathy, retinoblastoma, retinitis pigmentosa, choroidal neovascularization & anterior segment slit-lamp
- Live animal GFP & YFP fluorescent studies also possible
Retinal Structure:
Optical Coherence Tomography (OCT)
Optical Coherence Tomography (OCT)
R-4300 for Greatest Depth, R-2200 for Greatest Resolution

R4300 Whole Eye

Histology

Mouse

R2200 Posterior

R2200 Anterior

R2200 Periphery

SD-OCT

bioptigen

Envisu
Fluorescein Angiography
Retinal Function: Electroretinogram
Retinal Issues: Electroretinogram (ERG)

The basic waveform of the ERG

Fig. 13. ERG recordings in a normal patient and one with retinitis pigmentosa.
Welcome to the Broadway Research Building ~ Molecular Imaging Center and Cancer Functional Imaging Core Website

Welcome to the Molecular Imaging Center and Cancer Functional Imaging Core at the Broadway Research Building of the Johns Hopkins University School of Medicine. Noninvasive imaging has become a powerful tool in the investigation of various disease processes. Spectacular advances in MR, PET, SPECT, ultrasound, optical imaging as well as other modalities now provide unparalleled opportunities for combined anatomic, functional and molecular imaging.

The BRB Molecular Imaging Center and Cancer Functional Imaging Core provides state-of-the-art small animal imaging equipment, including MRI, PET, Spect, Ultrasound, Optical imaging, X-ray and CT, to support the wide range of scientific projects within the diverse research community of the Johns Hopkins University and beyond. Trained technologists will assist investigators in the use of the facilities.