UPMC Ophthalmology Resident Syllabus: Posterior Segment Laser Course

1. Laser Safety

2. History

- Introduction of non-monochromatic Xenon arc by Meyer Schwickerath for photocoagulation

3. Laser Physics

- LASER (Light Amplification by Stimulated Emission of Radiation)
  - -Spatial coherence: directional
  - -Wavelength coherence: monochromatic (but wavelength can be changed with tunable dye laser)
  - - Visible Spectrum (longer to shorter): ROYGBIV

4. Tissue Absorption

a. Retinal burns usually result from secondary heating
- -RPE melanin (primary)
- -Choroidal melanin
- -Hemoglobin

b. Light Scattering Tissues
- -Cornea
- -Cataractous lens, especially nuclear sclerosis
- - Vitreous hemorrhage

c. Light Absorption: pigment
- -Lens xanthochrome: peak absorption in blue spectrum
- -Blood hemoglobin
  - -Less absorption at red wavelengths
  - -Peak absorption at yellow wavelengths
- -Macular xanthophyll
  - -Located in IPL and OPL of neurosensory retina
  - -Peak absorption in blue spectrum; otherwise relatively ineffective absorber
- -Choroidal and RPE melanin
  - -Melanin is most important source of thermal photocoagulation
  - - Highest melanin concentration in RPE melanosomes

5. Guidelines for Selection of Wavelengths

- Avoid blue (420-490 nm): it is absorbed by melanin and hemoglobin but dangers to patient, absorbed by xanthochrome in nuclear sclerotic lens, scattered by non-nuclear sclerotic cataractous lens, and absorbed by macular xanthophyll
- Absorbing filters in slit lamp oculars and observation scope

-Protective goggles for observers: make sure the correct goggles for the appropriate wavelength of laser.

-Best Choices

a. Diode Green / YAG Doubling (532 nm)
   1) Readily available
   2) Minimal xanthophyll absorption
   3) Well absorbed by melanin and hemoglobin
   4) Good overall choice

b. Dye Yellow (560-580 nm) (not at UPMC)
   1) Now more readily available, most iridex lasers
   2) Also well absorbed by hemoglobin and melanin
   3) Also good choice for Argon green indication

c. Krypton Red (647 nm) or Dye Red (610-640 nm) (not at UPMC)
   1) Least scattered
   2) Minimal absorption by xanthophyll
   3) Minimal absorption by hemoglobin and good absorption by melanin
   4) Possible choice for media opacities such as cataract or vitreous hemorrhage but increased pain and increased risk of rupture of Bruch's membrane .

d. Diode Red Laser (near infra-red 780-840 nm)
   1) Requires 3X more energy than Argon green, but since emission wavelength of diode laser is close to maximum absorption of ICG, it can be used in conjunction with ICG to enhance treatment of CNV or choroidal tumors such as melanoma.
   2) Transpupillary Thermotherapy (TTT): Diode laser heats tissue causing coagulative necrosis - low power, large spot size, long duration

e. Photodynamic Therapy (PDT): IV infusion of photosensitizing drug
   1) Visudyne (verteporfin) with 693 nm nonthermal laser
   2) Fluorescein with Argon Blue (or Green)
   3) ICG with 810 nm diode

5. Laser Treatment Parameters

a. exposure / duration
   - Higher duration also more painful

b. power
   - -Intensity of burn is related to size squared
   - -pigmented race patients usually require less power
   - media opacity and cataract – more power
   - pseudophakia – less power
   - Periphery- hotter burns with contact lens or LIO

c. spot size

- can alter spot size by changing focus – ie pullilng back on joystick

Laser Spot Size in Emmetropic Eye

Lens	**Spot Size Multiplication Factor**
Area Centralis	1.01
Mainster	1.05
3-mirror Goldman	1.08
Panfundoscope	1.41
Mainster wide-angle	1.47
Kreiger	1.53
QuadrAspheric	1.92

d. wavelength

- Longer wavelengths generally produce deeper burns and more pain due to choroidal innervation

6. Laser Delivery System

a. slit lamp

- Lens Selection – Central and Peripheral

b. LIO (laser indirect ophthalmoscope)

- Lens Selection – 28 and 20

c. endolaser

-straight, curved, extendable

7. Complications:

a. Focal: foveal burn

- CNVM
- laser creep

b. PRP:

- pain,
- loss of accommdation,
- serous choroidals with or without secondary angle closure
- visual field loss

c. PDT: RPE atrophy

8. Clinical Indications for Laser

- Retinal Vascular Occlusion: CRVO, BRVO
- Diabetic Retinopathy, DME: focal, PRP
- Central Serous Retinopathy
- Other retinovascular diseases: Coats' Disease, Macroaneurysm, pars planitis
- Peripheral Retinal Degenerations: Retinal Tears, Lattice Degeneration
- AMD, other causes of CNV

9. Landmark Clinical Trials
    1. DRS (Diabetic Retinopathy Study)
    2. ETDRS (Early Treatment Diabetic Retinopathy Study)
    3. MPS (Macular Photocoagulation Study)
    4. TAP (Treatment of ARMD with Photodynamic therapy)
    5. VIP 1 (Verteporfin in Photodynamic Therapy: Myopia
    6. VIP 2 Verteporfin in Photodynamic Therapy: ARMD Occult
    7. BVOS (Branch Vein Occlusion Study)
    8. CVOS (Central Vein Occlusion Study)