Optic Nerve Disorders: Structure and Function and Causes

Using Visual Fields, OCT and B-scan Ultrasound to Diagnose and Follow Optic Nerve Visual Losses

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Susan Carleton Benes, MD, Professor of Clinical Ophthalmology at Ohio State, Staff at The Eye Center of Columbus, OSU, Children’s, Grant and Riverside
Goals (there are many)

• Do the best you can to help the most you can.
• LISTEN to the patients. They often tell you the diagnosis by their description!!
• Be as competent as you can (keep learning).
• You are important!
• FIRE UP! You are essential to the process!!!
• Get certified if you possibly can!
• Continue LEARNING!!!
Optic Nerve Visual Loss

• Sick Optic Nerve conducts less light
• Asymmetric: Marcus-Gunn afferent pupil defect (faster pupil on the good side, then the slower one appears to dilate as the light switches sides)
• Often, color vision is reduced, less red, if sick.
• Visual field defects:
  – Inflammation and infection (retrobulbar optic neuritis): central scotomas plus any other pattern
  – Toxins, malnutrition, Leber’s hereditary: cecocentral
  – Ischemia and compression: altitudinal and arcuate
  – Chiasmal: nasal fibers crossing, bitemporal VF defects
  – Retrochiasmal: L brain fibers see R visual space (homonymous)
Light Gets to the Optic Nerves

- Air
- Tear film
- Cornea
- Anterior chamber’s aqueous
- Lens
- Vitreous
- Many layers of Retina: through the clear layers to the RPE (retinal pigment epithelium), rebound to the Outer Nuclear Layer (ONL) photoreceptors (rods and cones), synapses with bipolar cells in the mid-retina, synapses with the Inner Nuclear Layer (INL) cells, whose LONG axons become the optic nerve (Cell Nuclei are Gray Matter)
Each Optic Nerve has Sections

- Leaving the INL (Inner Nuclear Layer), the axons become the Arcuate then Radial retinal nerve fiber layer (RNFL), conducting information from the gray matter to the tip of the optic nerve*
- The tip= “papilla” or “disc” or “nerve head”: 3mm in the eyeball, visible from the front, measurable with photographs and OCT
- Retrobulbar optic nerve (about 34mm in orbit) is behind the eyeball, gaining myelin coating, becoming “White Matter”. It cannot be seen without B-scan ultrasound, CT or MRI scans, or in surgery
- Canalicular optic nerve (6-12mm in the bony canal entering head)
- Intracranial optic nerve (1-10mm in the head before the chiasm)
- Chiasmal optic nerve (sloping upward at 45 degrees, over pituitary)
- Retrochiasmal optic nerve= the “optic tract”
- Synapse! Fibers going to the occipital lobe for us to “know we saw” make a connection in the Lateral Geniculate Body
RNFL= beginning of the optic nerve

- ARVO paper 2014: Inner retinal optic neuropathy: vitreomacular surgery-associated disruption of the inner retina (IRON)
- Pan BX, Yee KM, Ross-Cisneros FN, Sadun AA, Sebag J. authors
- 11 patients: 4 postop membrane peeling with central scotomas 20/600, 7 without 20/30+ 
Acute One-eyed Visual Loss w Discomfort

• If pain precedes visual loss: suspect primary retrobulbar inflammation or uveitis inflammation, with secondary optic nerve

• If febrile illness with (or preceding in the past 6 weeks), consider parainfectious optic neuritis, often with photophobia, but may be painless

• If pain on eye movement develops, consider retrobulbar optic neuritis, some cases isolated (CIS=clinically isolated syndrome), and some cases associated with MS (multiple sclerosis, demyelinating disease)
Acute Painless Monocular Visual Loss

• Common: non-arteritic anterior ischemic optic neuropathy (NAION)

• Less common: arteritic ischemic optic neuropathy (AAION) (Giant Cell Arteritis= a true medical emergency)

• Less common: posterior ischemic optic neuropathy (PION)
  – Setting: face-down spine surgery, on/off cardiac pump
  – Setting: vasculitis, auto-immune disorders, radiation
Gradual Monocular Visual Loss

• Infiltrative processes
  – Cancers from the skull base
  – Cancers from the dura invading into the nerve
  – Sarcoid and chronic infections

• Intra-sheath processes
  – Arachnoiditis, meningitis, meningioma
  – Effusions, abscesses, hemorrhages, cystic collections

• Intra-optic nerve processes
  – Optic neuritis (infectious and inflammatory)
  – Optic gliomas (benign and malignant)
40 year old lady with gradual visual loss OD over 5 years.

R eye: 20/80 R and R MG afferent pupil defect.

L eye: 20/20

B- scan ultrasound (above) of globes and optic nerves:

R eye: wide ON sheath 8.12mm at 10mm back
R thick, lumpy arachnoid beneath nerve
R thick choroid from venous obstruction
R thin line of CSF (cerebrospinal fluid)

L eye: 6.39mm (n<7.35)
L normal nerve, invisible A
L normal choroid (0.8-1.2)
L normal CSF (2-3-2)
Gradual Bilateral Visual Loss

• Common with Cupping: Glaucoma
• Rare: Cupping without Glaucoma
• Common with Swollen Optic Nerves:
  – Disc Drusen
  – Papilledema
  – Infiltration inside both optic nerve sheaths
  – Infiltration in the chiasm
  – Compression of the chiasm
New: Stem Cell Studies

• Embryonic stem cells: from certain “cell lines”
  – Some stimulated to be RPE monolayers
  – Others can be stimulated by growth factors otherwise

• Autologous stem cells: from yourself
  – Bone marrow cells
  – Adipose stem cells (fat)
  – Other stem cells

  – Check out www.clinicaltrials.gov!!!!
Truisms

• You are unique: you can educate your patients! Directly!
• Teach your patients! They will partner with others and advocate for themselves!
• All “cupping” is NOT glaucoma
• All “papilledema” is NOT raised intracranial hypertension
• **Acute** etiologies don’t equal **Chronic** etiologies
• Certain “syndromes” have different:
  – History
  – Exam
  – VF
  – OCT
  – B-scan ultrasound