Imaging in Ophthalmology

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Charlottesville, VA
Disclosure

- Are you kidding? This is Neuro-ophthalmology
- No I’m not a radiologist (?) Want to be)
HJH 63yo male

3/97: 1day h/o sudden visual loss OD
Va NLP, 20/20
P: >3log RAPD
EOM: ↓ elevation/depression OS
HJH - PMH

12/96: 1day h/o pain OS + diplopia
Ptosis + ↓adduction → Dx: “diabetic L IIIrd”

1/97: Diplopia better

2/97: Abduction deficit → Dx: “diabetic R VI”
HJH - W/U

MRI:
LFH 84yo female

2/94: “Second opinion”

1983: Ta: 26 → Dx: glaucoma; Rx: Timoptic

LFH - F/U

2/94: No complaints

Va 20/25, 20/50

N 3pt, 4pt

VF:

P: w/o APD

SLE: 1-2+NS

Ta: 16/20

MRI:
LFH - Review

VF (7/93):
Introduction

• There is no “Orbitobrainogram”
• Imaging is expensive (limited resources)
• Newer imaging techniques may take longer
  – Only certain sequences are possible
  – Only certain areas can be imaged
History

• Roentgen and discovery of x-rays (1895)
• First use of x-ray ophthalmology (1896)
• Pneumoencephalography (1918)
• Angiography (Moniz 1927)
• CT scan (early 1970’s)
• MRI (late 1970’s)
Introduction

- When to order
- What to order
- How to order
When Not to Order

• When you won’t look at the results
• When previous studies done and not reviewed
• When it won’t change what you are doing
• When the chance of a mass lesion is remote
When Not to Order

- Acute Va loss, disc edema in older patient
- Arcuate VF loss, preserved Va, inc CDR
- Isolated ocular motor palsy in vasculopathy
  - IVth nerve palsy w/ or w/o CHI
  - VIth nerve palsy
  - Pupil sparing IIIrd nerve palsy
- Pain without numbness
ELB 48yo male

2/09: “optic neuritis”

Va 20/20 OU

N 3pt OU

VF:

Ext: w/q

P: .3log LAPD

EOM: full

SLE: wnl

Ta: 21/18

Fundus:
ELB - POH

1999: painless ↓Va OD

No dx

Improved

2/09: “Bottom part of vision blurry OS”
ELB - W/U

OCT NFL (2/09):

**RNFL THICKNESS AVERAGE ANALYSIS**

- **OD**
  - Microns: 300
  - Temp: 0, 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240
  - Sup: 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 310, 320, 330, 340
  - Nas: 350, 360, 370, 380, 390, 400, 410, 420, 430, 440, 450, 460, 470, 480, 490, 500
  - Inf: 510, 520, 530, 540, 550, 560, 570, 580, 590, 600, 610, 620, 630, 640, 650, 660
  - Temp: 680, 700, 720, 740, 760, 780, 800, 820, 840, 860, 880, 900, 920, 940, 960, 980

- **OS**
  - Microns: 300
  - Temp: 0, 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240
  - Sup: 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 310, 320, 330, 340
  - Nas: 350, 360, 370, 380, 390, 400, 410, 420, 430, 440, 450, 460, 470, 480, 490, 500
  - Inf: 510, 520, 530, 540, 550, 560, 570, 580, 590, 600, 610, 620, 630, 640, 650, 660
  - Temp: 680, 700, 720, 740, 760, 780, 800, 820, 840, 860, 880, 900, 920, 940, 960, 980

**Signal Strength (Max 10)**: 10

**Patient/Scan Information**
- **DOB**: 1/4/1961
- **ID**: 21009757
- **Sex**: Male
- **Scan Type**: Fast RNFL Thickness (3-4)
- **Scan Date**: 2/19/2009
- **Scan Length**: 10.87 mm

**Normal distribution Percentiles**
- 100%
- 95%
- 5%
- 1%
- 0%
ELB - F/U

5/09: “Worse”

Va 20/20 OU

N 4pt, 6pt

VF:

Ext: w/q

P: w/o APD

EOM: full

SLE: wnl

Ta: 26/22

Fundus:
ELB - W/U

OCT NFL (5/09):

RNFL THICKNESS AVERAGE ANALYSIS

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<tr>
<th>Microns</th>
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OD

OS

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<th>OS (N=3)</th>
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<td>Avg.Thickness</td>
<td>73.54</td>
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Analysis Confidence Low

Signal Strength (Max 10)

Signal Strength (Max 10)

Normal distribution Percentiles

Patient/Scan Information

DOB: 1/4/1961, ID: 2108757, Male

Scan Type: Fast RNFL Thickness (3.4)

Scan Date: 5/12/2009

Scan Length: 10.87 mm
QMS 10yo male

1/92: 1yr h/o decreased vision OS

Va: 20/20, 20/100

N: 3pt, 26pt

VF:

Ext: w/q

P: .6log LAPD

EOM: full

SLE: wnl

Fundus:
QMS - F/U

3/92 (2mo): Blurred Va OD

Va: 20/80, 20/100

VF:

Ext: w/q

P: w/o APD

EOM: full

SLE: wnl

Fundus:
Mitochondrial analysis: point mutation 11778
CES 72yo male

6/97: 6wk h/o intermittent diplopia; 3wk L ptosis

Va: 20/25 OU; N: 3pt, 4pt; VF: full

Tensilon test:
When to Image Afferent System

• Evidence of an optic neuropathy
  – Acuity loss + VF changes
  – Progression
• Bitemporal visual field (presume chiasmal)
• Homonymous hemianopsia
  – Tract/radiation/cortex
  – Ischemic/neoplastic/inflammatory
MKE 51yo female
1/01: 2wk blur OD
Va 20/20 OU
N 5pt, 3pt
VF:
Ext: H 14/12
P: dilated
EOM: full
SLE: tr NS
Fundus:
MKE – W/U
F/A (1/01):
MKE – W/U

Dx: AION
MKE – F/U

2/07: Gradual ↓ Va

Va 20/60, 20/20

N 26pt, 3pt

VF:

Ext: w/q

P: 1.2log RAPD

EOM: full

SLE: tr NS

Ta: 16 OU

Fundus:
MKE – W/U

MRI:
GHP 35yo male

2/88: 1wk h/o HA + blurred Va

Va 20/20 OU

N 3pt OU

10/10 HRR OU

VF:

P: w/o APD

EOM: symmetric OKN
GHP - W/U

CXR:

CT:

Lymph node bx: Germ cell tumor; Rx: chemotherapy
When to Image Diplopia

- With evidence of orbital pathology
  - Proptosis
  - Injection
  - Bruit
  - Sensory changes
- Skew deviation
- Atypical ocular motor palsies
JTC 48yo male

3/97: 2mo diplopia

Va 20/20 OU

N 4pt OU

VF: full

Ext: H 23.5/17.5, ↓ sensation R V2
JTC - W/U

MRI:
MJM 26yo male

4/97: 3-4yr h/o “problems w/ tracking”

Va 20/20 OU

N 3pt,4pt

VF: full

P: w/o APD

EOM: abnormal pursuit at zero velocity, E

SLE: wnl

Fundus: nl DMV
When to Image Ocular Motor Palsy

- When it is not isolated
- When it is progressive
- Pupil involvement III
- Evidence of aberrant regeneration III
MES 66yo female

1/91: 1mo h/o diplopia

Va 20/40, 20/200

N 3pt, 5pt

VF: diffuse depression

EOM:

Ext: ↓ sensation V1&2
MES - W/U

MRI:
DJH 37yo male

7/97: 2wk h/o diplopia

Va 20/15 OU

N 3pt OU

VF: full

Ext: w/q

P: w/o APD

EOM: ET ↑ on L gaze

SLE: wnl

Fundus: nl DMV
GWA 58yo male

9/93: 1wk h/o diplopia + lid droop

Va 20/50,20/40

N 3pt OU

VF: full

Ext: 4mm L ptosis

P: 4.2/4 w/o APD

EOM: ↓ elevation, depression, adduction OS
Squamous cell carcinoma of the neck

Review previous neck CT:
GWA - W/U

MRI:

Bx: squamous cell Ca  Rx: RT
When You Don’t Image

- You must follow the patient
  - Is the natural history expected
  - Does “microvascular” CN palsy entirely resolve?
  - Does disc edema resolve w/ residual VF defect?
- Reconsider imaging if atypical features
- “Peace of mind”
Information from Imaging

- Localization
- Characteristics
- Definitive diagnosis
- Change over time or with treatment
Localization

• Suggested by history

• Confirmed by physical examination
Localization

- **Orbit**
  - **Globe**
    - Anterior segment
    - Retina/choroid
  - **Retrobulbar space**

- **Intracranial**
  - Parasellar/superior orbital fissure
  - Supratentorial/infratentorial
Localization - Intracranial

• Parasellar
  – Optic chiasm
  – Cavernous sinus/superior orbital fissure/clivus

• Middle cranial fossa
  – Visual pathways
    (tract/geniculate/radiations/cortex)

• Posterior cranial fossa
  – Brainstem (midbrain/pons/medulla)
  – Cerebellum
Pathophysiology

- Vascular
- Neoplastic
- Inflammatory (Infectious)
- Traumatic
- Toxic
- Metabolic
- Hereditary
Associated Symptoms

- Other cranial nerve palsy (V, VII)
- Long tract signs
- Cerebellar signs
- Higher cortical dysfunction
- Mentation changes
Intracranial Information

- Intra- vs extra-axial
- Relationship to visual pathways
- Relationship to vascular structures
- Relationship to ventricular system
- Relationship to the paranasal sinuses
Intraorbital Information

- Intraocular
- Relationship to the optic nerve
- Intra- vs extra-conal
- Relationship to the bones of the orbit
- Relationship to the lacrimal gland/sac
What to Order

- Plain films: rarely indicated
- CT
- MRI
- Angiography
  - MRA/CTA
- Functional MR/MR spectroscopy
- Positron emission tomography (PET)
Imaging – General Principles

• CT superior for bone and acute trauma
• CT superior for FB (except wood)
• MRI superior for intracranial pathology
• CT & MRI often complementary
  – Both useful in the orbit
KLS 32yo female

12/95: “Difficulty focusing”

Va 20/20,20/15

N 3pt OU

VF:

Ext: H 15 OU

P: w/o APD

EOM: full

SLE: wnl

Fundus: nl DMV
Review CT scan done to evaluate galactorrhea:
AJS 27yo male

4/97: Periocular swelling after blowing his nose

Va 20/20 OU

VF: full

Ext: H 23/21, crepitus

EOM: ↓ elevation OD

CT:
CRM 3yo male

4/02: Fell while climbing a tree

Va CF OD, unobtainable OS

Ext: 2+ edema OS

EOM: absent abd OS

“Air in orbit”
CRM - F/U

4/02 (10d): No Complaints

Va 20/30 OU

VF: full

Ext: w/q

EOM: full
CLC 30yo male

7/87: 1wk h/o painful swelling OD

Va 20/20,20/15

VF: full

Ext: 1+injection OD, H 17.5/13

P: w/o APD

EOM:
CLC - W/U

CT:

W/O Contrast    W/ Contrast
CLC - Dx: Idiopathic Orbital Inflammatory Disease/Myositis

Rx: Prednisone

F/U: “Better”

Va 20/20, 20/15

Ext: H 13.5 OU

P: w/o APD

EOM:
CT Limitations

• Low but cumulative radiation dose
• Poor resolution at orbital apex
• Beam hardening artifact in posterior fossa
• Possible allergic reaction to contrast
JWC 22yo male

4/96: 3mo h/o “lump” R brow

Va 20/20, 20/15

VF: full

Ext: H 20.5/16, sensation intact

P: w/o APD
JWC - W/U

MRI:
Indications for CT

• Question fracture
• Question metallic foreign body
• Acute hemorrhage
  – Subarachnoid hemorrhage
  – Pituitary apoplexy
• Orbital infectious process
• Bone detail (pre-op planning)
• Contraindication to MRI
Contraindications to MRI

• Implanted ferromagnetic device
  – Cochlear implant
  – Pacemaker
  – Retained metallic FB

• Relative contraindications
  – Weight
  – Claustrophobia
  – Risks of sedation when uncooperative
CGR 82yo male  POH: L epiretinal membrane

10/95: ↑difficulty w/ reading

Va 20/25, 20/200

N 4pt, 8pt

VF:

P: w/o APD

EOM: 3Δ LH

SLE: 2+NS

Fundus:
CGR - W/U

MRI scan order; Cancelled due to pacemaker

Return 3 wks for repeat VF

12/95: Phaco OS

4/96: Repeat vitrectomy epiretinal mebrane peal
CGR - F/U

8/96: Episodes of confusion

Va 20/25, 20/400

VF:

P: 1.2 log LAPD
CGR - W/U

CT:
Nonradiologist & MRI

- **T1**: localization (best anatomy)
  - Gadolinium (identifies abn blood/brain barrier)
  - Fat Sat (T1 w/ fat signal suppressed)
- **T2**: identification abnormal tissue
  - FLAIR (T2 image suppress ↑CSF signal; not orbit)
- **DWI**: detects early infarct
- **Perfusion**: detects gross blood flow abnormalities
Nonradiologist & MRI

- T1: Fat >> white > gray > vitreous/CSF > air
- T2: Vitreous/CSF >> gray > white > fat > air
- FLAIR: Fat > gray > white > vitreous/CSF > air
ESA 82yo female

4/97: 1day h/o L ptosis and pain

N 10pt, 14pt

VF: full

Ext: 3mm L ptosis, H 15/17

EOM: ↓ up gaze OS
ESA - W/U:

MRI:
ESA - Dx: Idiopathic orbital inflammatory disease
Rx: Indocin
F/U (1wk): Resolved pain, decrease diplopia
Va 20/40, 20/30
N 5pt, 4pt
Ext: H14/16, 2mm L ptosis
EOM: ↓ up gaze OS
ELB 52yo female

5/97: 6yr h/o “orbital pain”

Va 20/20 OU

N 4pt OU

VF: full

Ext: palpebral fissures 6 OU, H 12 OU

P: w/o APD

EOM: full

Fundus:
ELB - W/U

MRI:
ERM 63yo male

6/14: 2wk red eye

Va 20/30 OU

N 5pt, 6pt

VF: nl 24-2

Ext: 1-2+inj OS

P: w/o APD

EOM:

SLE: chemosis, trNS

Ta: 16 OU

Fundus: CDR .5
ERM - W/U

MRI (6/13):
ERM - PMH

2012: Nevus abdomen Δ size

2/12: Bx: melanoma

Rx: wide excision

PET (5/12): RLL nodule

PET (11/12): uptake R axilla & R breast

1/13: Rx: vemurafenib
ERM - W/U

MRI (6/13):
SLL 44yo female w/ chronic atrial fibrillation

3/96: Sudden onset HA

Va 20/20 OU

P: .3log LAPD

EOM: ↓ pursuit right

VF:

Fundus:
SLL - W/U
CT:
SLL - W/U

MRI:

Iso: deoxyhemoglobin

White: intracell methemoglobin
Proton Density

Dark: intracellular methemoglobin

T2 bright: extracellular methemoglobin, edema
MAD 35yo male

7/97: 1day h/o pain w/ eye movement

Va 20/20 OU

2days later “Vision dim”

Va 20/20,20/200

N 3pt,26pt

VF:

P: 1.8log LAPD
MAD - W/U

MRI:

FLAIR
Angiography

- Presence of a Fistula or AVM
- Detection of aneurysm
  - CTA/MRA: >95% over 4mm
- Pretreatment embolization
ECW 23yo male

6/88: “Blurred vision R eye”

Va 20/15 OU

N 3pt OU

P: w/o APD
ECW - W/U

CT:
ECW - W/U

Angio:
ECW - Rx

6/99: embolization

VF (3 days post embolization):
How to Order

- As much information as possible
- Suspected location
- Differential diagnosis
- Discuss personally with radiologist if possible
How to Interpret Results

- Neuro-ophthalmology: “The reinterpretation of previously negative imaging studies”
- Importance of reviewing films
- The risk of “Image Worship”
MBC 60yo female

7/96: 6wk h/o “red eyes,” 5wk h/o double vision

CT: “negative” Rx: prednisone

Va 20/15, 20/20; N 3pt OU; VF: nl 24-2

Ext: 2+ inj, mod chemosis; Ta: 40/26
MBC - W/U

Review CT scan:
MBC - W/U

Angio:
TB 41yo female

1989: “Flashing lights” OD; “Swollen nerve”

“Couple of MRI’s & 2 LP’s; Told she had “mild MS”

8/96: Progressive visual loss OD

Va 2/200, 20/20

N 3pt OS

P: 1.2log RAPD
TB - W/U

Review MRI (3/94):
TB - W/U

8/96: Repeat MRI:
OUT PATIENT RADIOLOGY CONSULTATION FORM
UNIVERSITY OF VIRGINIA

IMPORTANT: All information requested on this form is essential and must be completed to proceed with the exam.

Patient Name: THERESA
History Number: 1328949 OR
Attending MD: (Required) (Print) STEVEN NEWMAN MD
Ordering MD: (Required) (Print) SADIE (Signature)
Address/Clinic: ORTHOPEDICS BOX 475 UVA CLINIC VA 22908
Phone and/or PIC: 924-5485
Fax: 924-5180
Exam Date: 8/17/96 10:00 AM

Please Check
Plain Films: [ ]
CT: [ ]
MRI: [X]
Fluoro: [ ]
Angio/Inter.: [ ]
Other: [ ]

Type of Exam(s) Requested:
MRA, ORL, MRI
2 fat sat. gadolinium

Clinical Indications:
progressive axial neurology
60 optic nerve sheath meningioma
40 optic neuritis

ARE FILMS TO RETURN DIRECTLY TO CLINIC WITH THE PATIENT? YES [ ] NO [CIRCLE ONE]

Additional Information (grant #, preauthorization #, Workman’s Comp, etc.):
TB - W/U

11/96: Repeat MRI:
DCJ 63yo male

3/03: 13mo h/o L facial numbness

2mo h/o diplopia

PMH:

8/01: during dental work lesion noted L cheek

9/01: Punch bx: squamous cell CA

Moh’s surgery scheduled

2nd biopsy “negative”

2/01: numbness L cheek
DCJ – PMH

Dx: “Trigeminal problem”

MRI suggested

Neurology consult: normal

7/02 MRI: normal

8/02: “Second opinion”

8/02: 2nd MRI negative; Dx: “trigeminal neuralgia”

Rx: Trileptal – no improvement

10/02: Spread of numbness to L upper face
DCJ – PMH

2/03: onset of oblique diplopia

1 diopter L hyper

2/03: 3rd MRI: ? abnormal L trigeminal

Rx: Imitrex

Referred to Emory

3/03: 4th MRI: “normal”

Review of the MRI: enhancement V in floor CS

Craniotomy suggested
DCJ – F/U

3/03: Referral UVA

Va 20/20,20/25

N 3pt,5pt

VF: nl 24-2

Color: 10/10 HRR OU

Ext: absent sens LV1,2; H 14.5/14

P: 5/4.5 w/o APD

EOM: 8Δ LHT, 5Δ X

SLE: 1+ NS, SPK OS

Fundus: nl DMV
DCJ – W/U

Cocaine test: no dilatation OS

Review MRI:
DCJ – W/U

Transmaxillary biopsy L inferorbital nerve

Path:
Conclusion

• When: don’t order if it won’t matter

• What:
  – MRI for intracranial pathology
  – CT for trauma/orbit

• How: as much information as possible
  – Localization based on history/physical