

# “The Tale of the Tell-Tale Pupil”

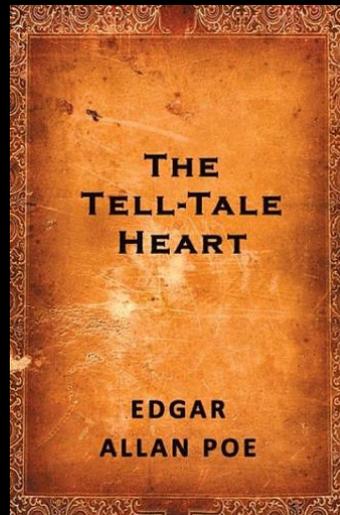
Leonard V. Messner, OD, FAAO  
Professor of Optometry  
Vice President for Strategy & Institutional  
Advancement  
Illinois College of Optometry



# Disclosure Statement:

- King Devick Technologies (board of directors)
- Heidelberg Engineering (scientific advisory board)
- Horizon Therapeutics (scientific advisory board)

“I think it was his eye! yes, it was this!...I made up my mind to take the life of the old man, and thus rid myself of the eye for ever.”



Edgar Allen Poe (from The Tell-Tale Heart – 1843)

# Key Points

- Pupil testing
- Common pathologic pupillary abnormalities:
  - Afferent pupillary defects
  - Tonic pupils
  - Horner syndrome
  - CNIII palsy

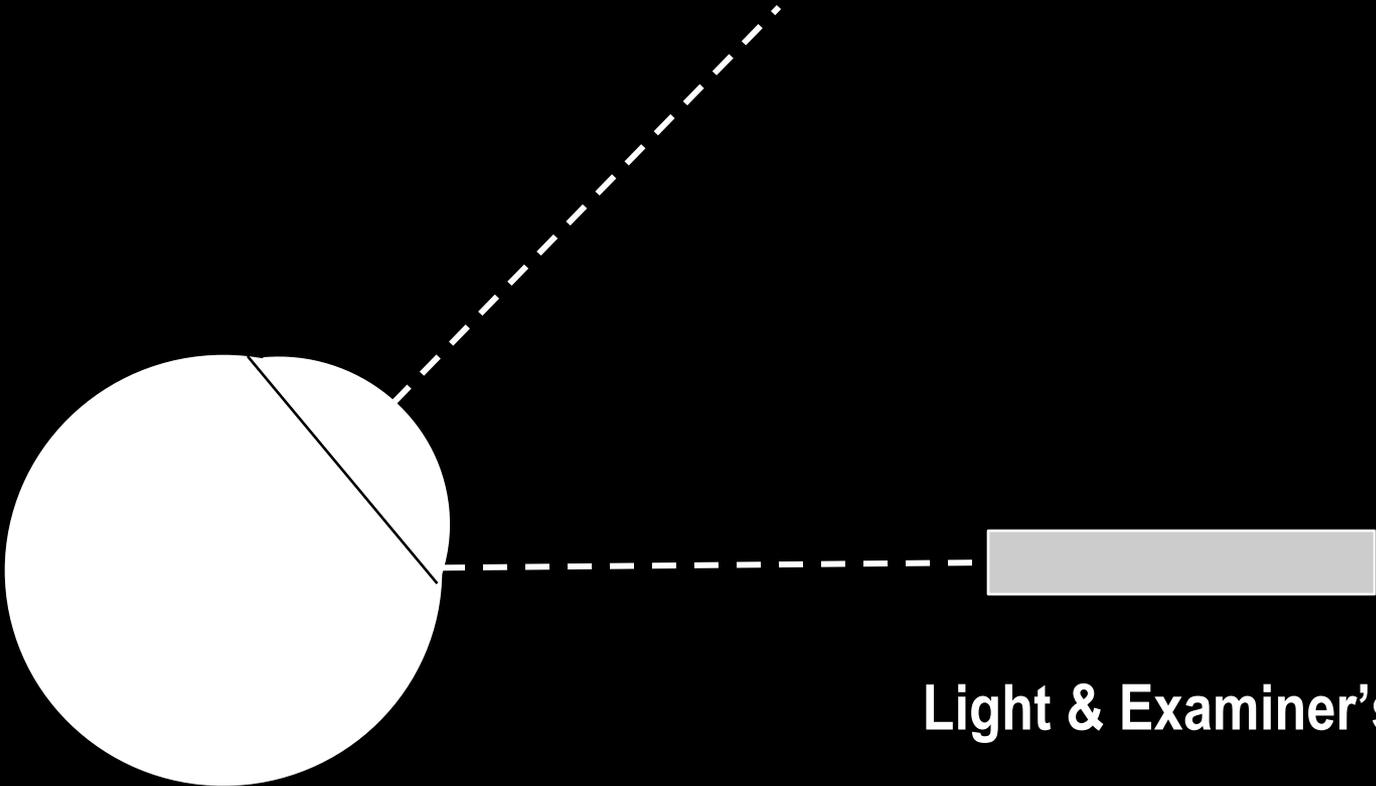
# *Pupil Testing*



# Modified Upgaze Technique for Pupil Examination

- Instruct the patient to “look up” at a point on the ceiling (approx 40 degrees above the midline)
- Introduce the light source toward the lower limbus
- Advantages:
  - Reduction of blink reflex (engagement of levator)
  - Pupil is not obscured by the Purkinje-1 image
  - Magnification of pupil

**Patient's Visual Axis**



**Light & Examiner's Visual Axis**

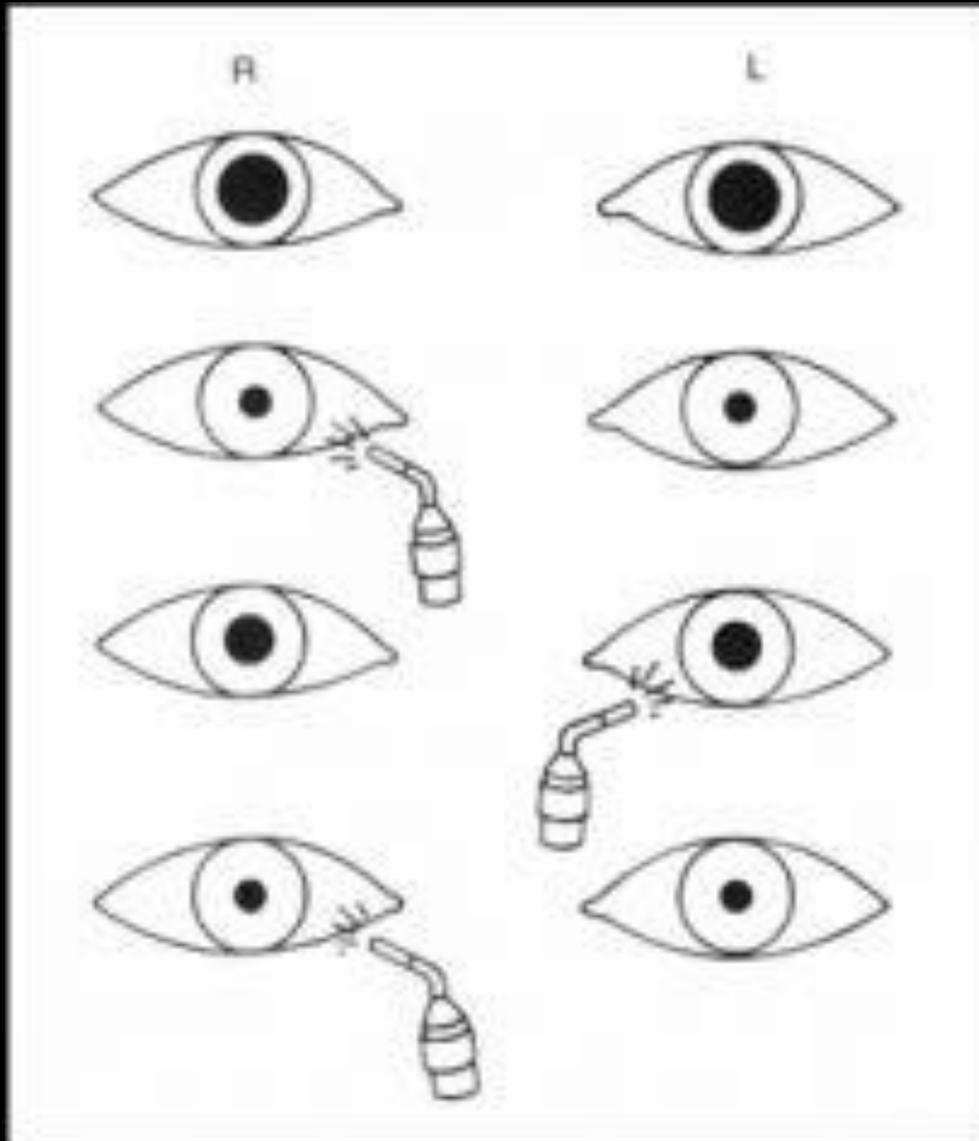
The Relative Afferent  
Pupillary Defect  
(Marcus Gunn Pupil)

# Epidemiology and Pathology

- Damage to afferent visual system
- Asymmetric disease
- No anisocoria
- *Relatively unaffected* by media opacities
- *Signature of optic neuropathy*

# The Swinging Flashlight Test

H. Stanley Thompson - 1976



The consensual response  
*induced* by the “good” eye  
is greater than the direct  
response *produced* by the  
“diseased” eye.

# 28 y/o woman

- Acute vision loss OS
- Pain on eye movement OS
- BVA:
  - 20/20 OD
  - 20/400 OS
- Afferent pupillary defect OS





HAR

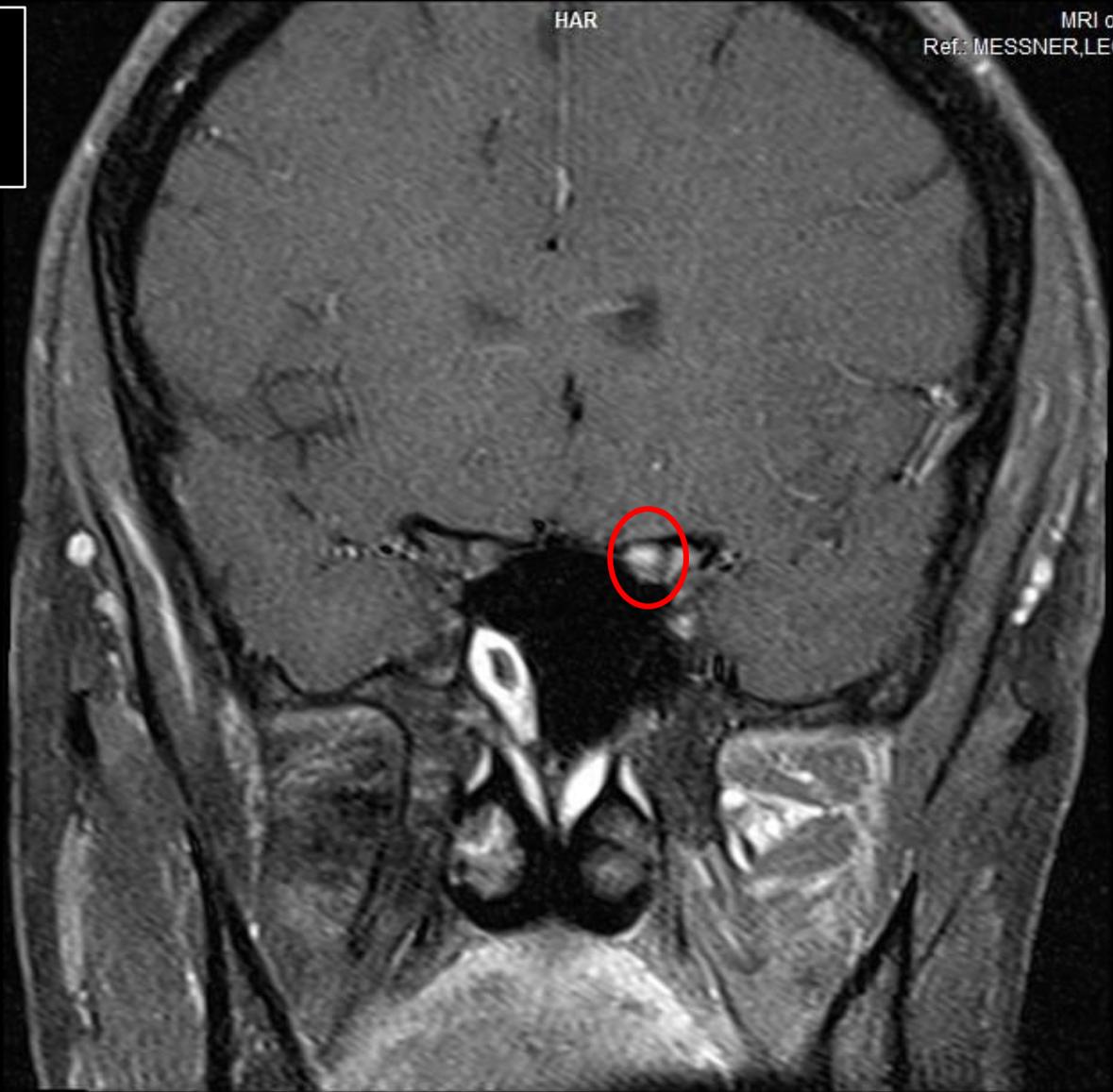
MRI of River North  
Ref.: MESSNER, LEONARD, ... OD  
Espree  
HFS

RP



SL 4  
TE 8.8  
TR 704

SP P0.4  
FoV 140\*140  
384p\*512 I  
Cor>Tra(-10.3)>Sag(-1.6)  
W: 1222  
C: 593



# Etiology of Afferent Pupillary Defect

- Signature of unilateral/asymmetric optic neuropathy
  - Demyelination/optic neuritis
  - Infarction/ischemic optic neuropathy
  - Compressive optic neuropathy
  - Traumatic optic neuropathy
  - Glaucoma (asymmetric)
  - Papilledema (asymmetric)
  - Retinal disease
    - Central retinal artery occlusion
    - Central retinal vein occlusion (non-perfused)

# Tonic Pupils

# Causes of Tonic Pupil

- local (orbit)
- infection
- inflammation
- ischemia
- tumor
- anesthesia (R-B block)
- s/p surgery
- toxicity (quinine)
- s/p laser
- trauma
- neuropathic (diabetes)
- s/p CN III palsy
- ***Adie's syndrome***

# Adie's Syndrome

• Prevalence	2/1000
• Mean age	32
• Female/Male	2.6:1
• Reduced deep tendons	89%
• Sector palsy	100%
• Accommodative paresis	66%
• Denervation supersensitivity	80%
• Decreased corneal sensitivity	90%
• Unilateral	80%
• Bilateral	4%/yr (miosis)

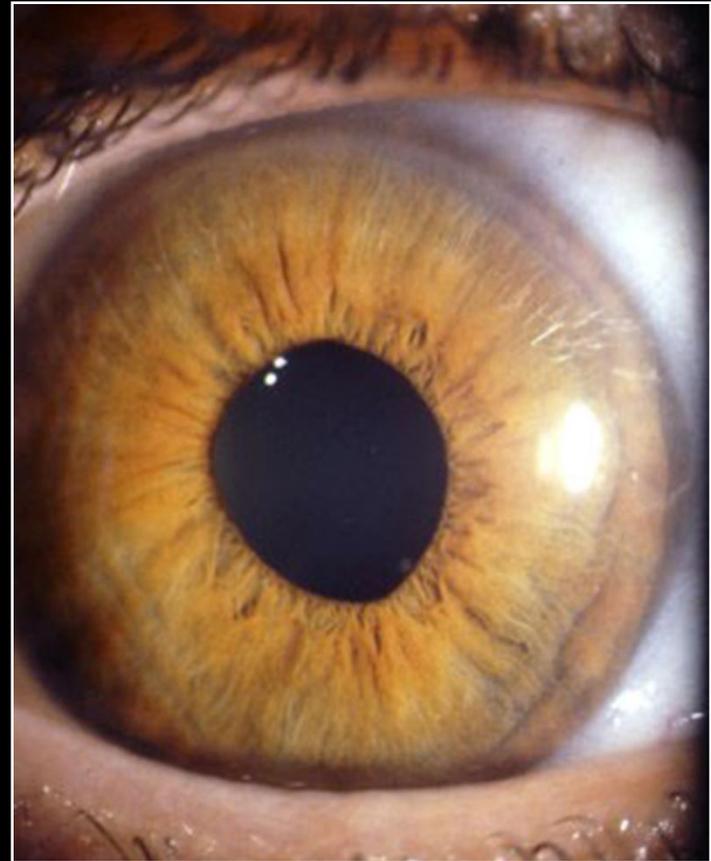
*Bilateral,  
miosis with  
age*

**“Little  
Old  
Adie’s”**



# Clinical Features of Adie's Tonic Pupil

- “Flat” edges
- “Vermiform” iris movement
- Poor response to light & near or LND
- “Dilation lag” following prolonged near effort
- “Paradoxical Pupil” - anisocoria greater in light & dim



# 28 y/o Woman

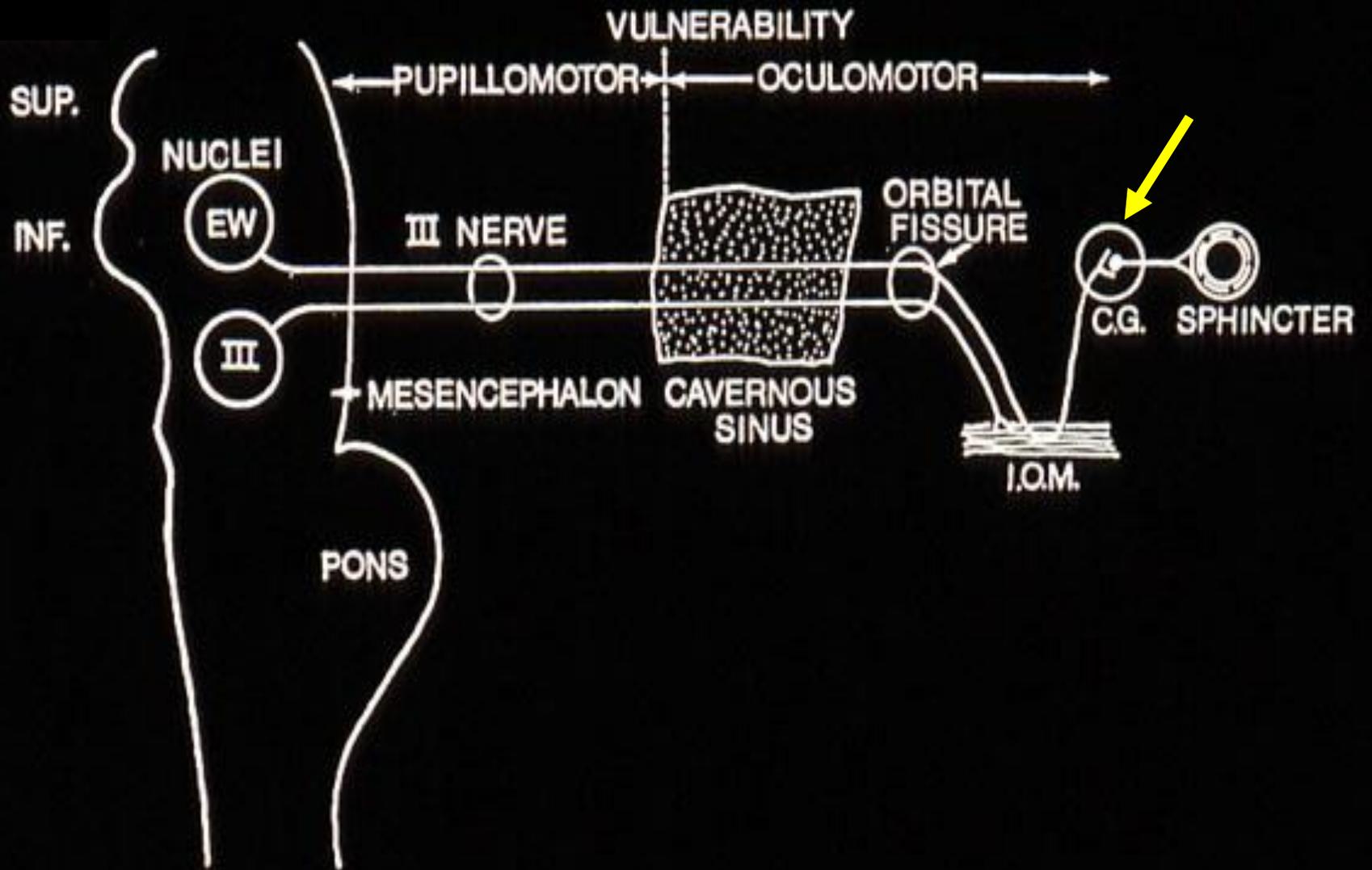
- Anisocoria that reverses from bright to dim illumination
  - Right pupil larger in light and smaller in dim



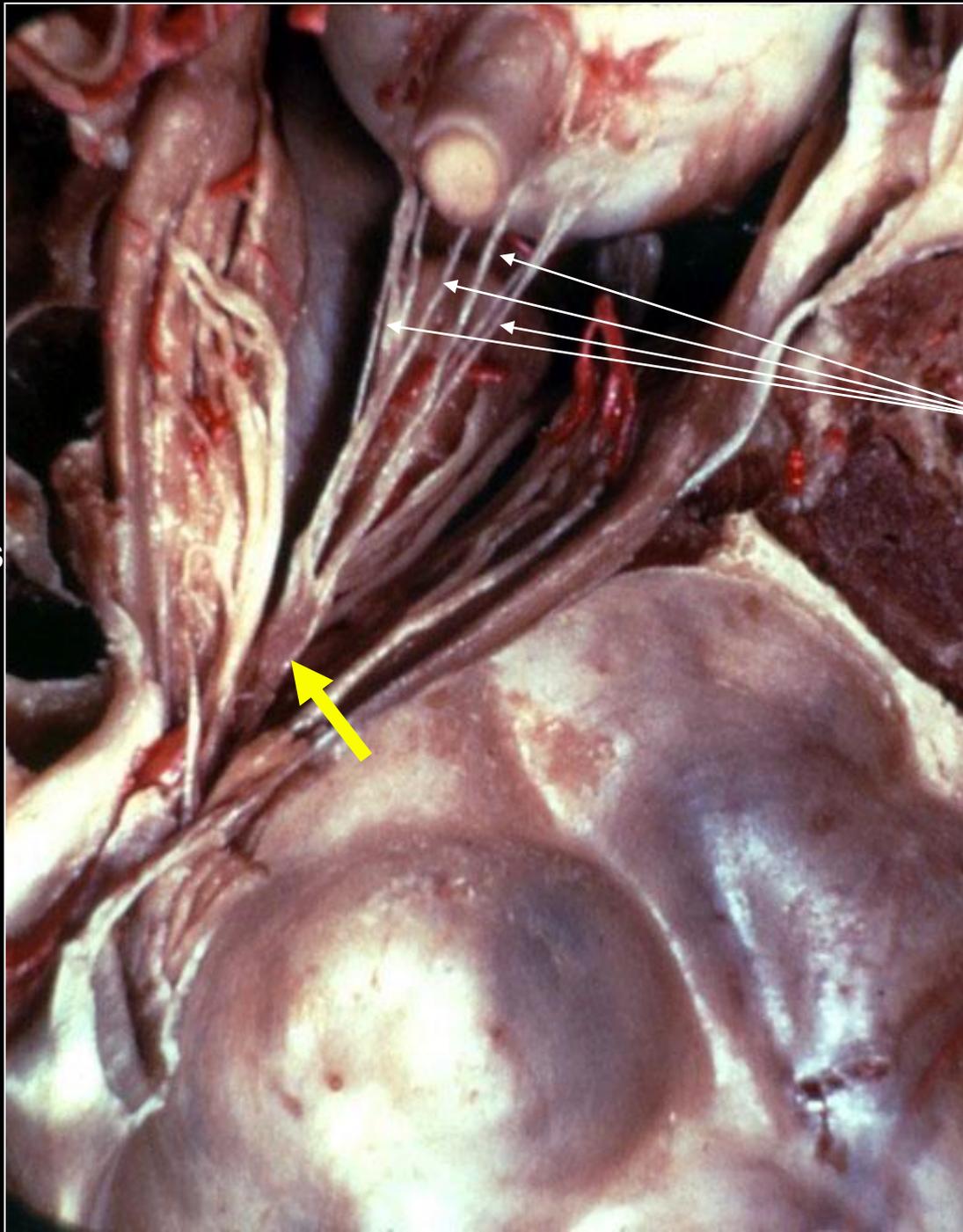
Pupil testing



Testing for corneal sensitivity



- Ciliary ganglion
- Parasympathetic CN III (synapse)
  - Oculosympathetics
  - Nasociliary V1



short  
ciliary  
nerves

# Pathogenesis of Adie's Tonic Pupil

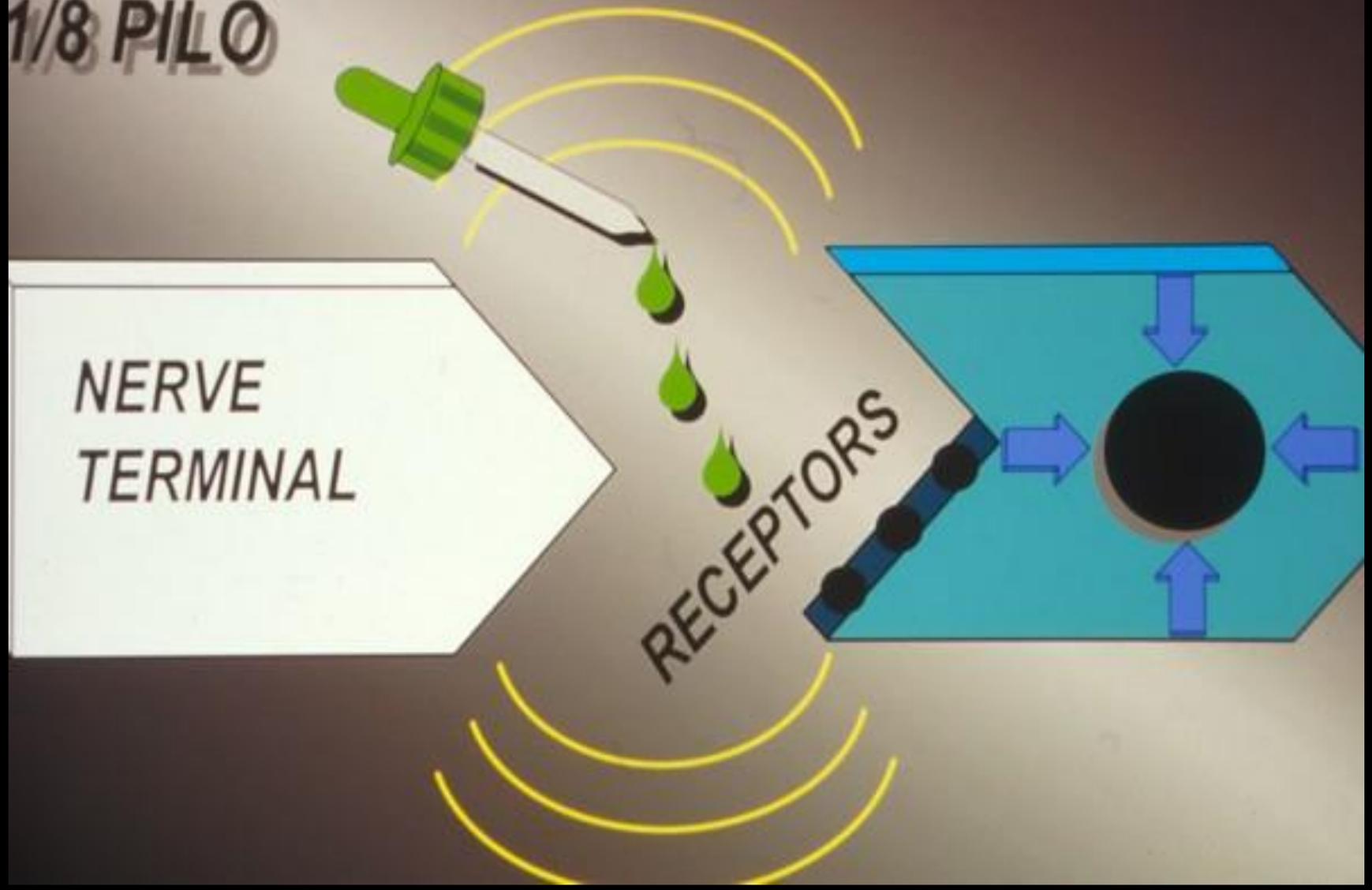
- Ciliary ganglion
  - 90% CB
  - 3% iris
- Aberrant regeneration of CB fibers to iris sphincter (light-near/gaze pupil dissociation)

# Pharmacologic Testing for Adie's Tonic Pupil

- Weak (1/8 or 1/10) pilocarpine
- Miosis owing to “denervation supersensitivity”
- *Acquired phenomenon*

# SUPERSENSITIVITY

1/8 PULO



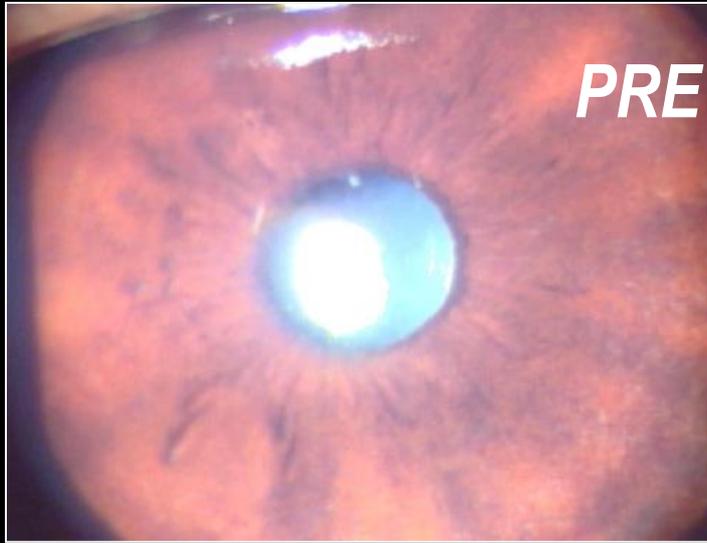
NERVE  
TERMINAL

RECEPTORS

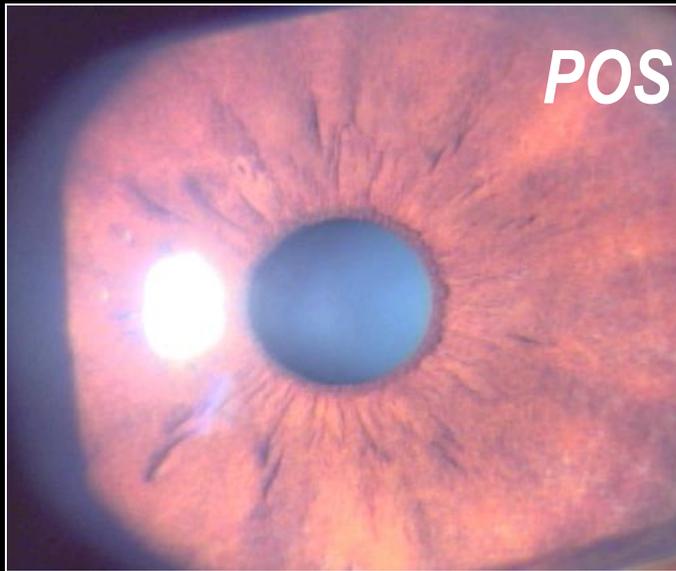
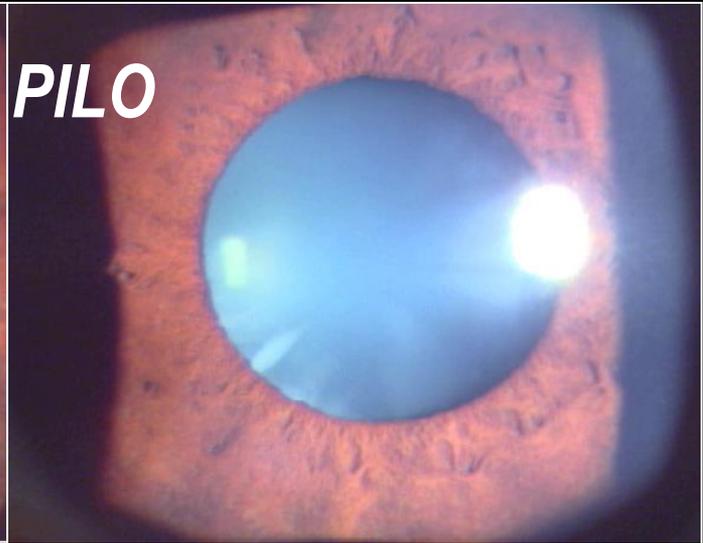
**1/8 PILOCARPINE**



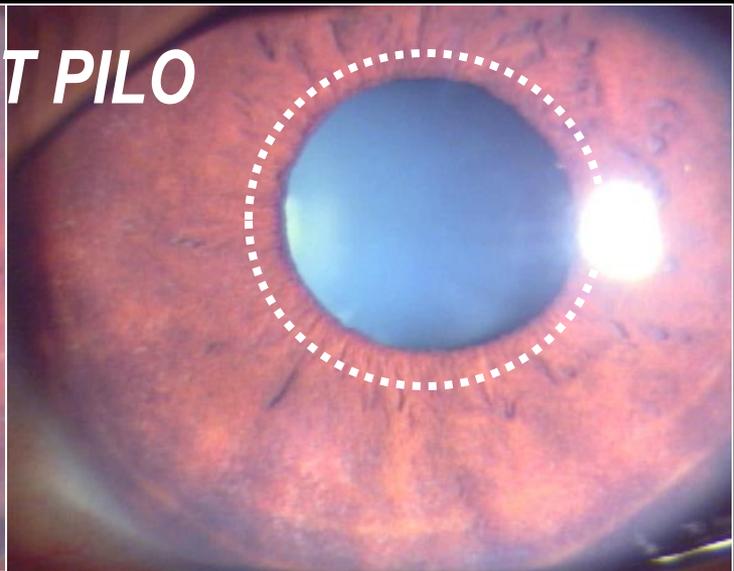
**NEUROLOGIC**



***PRE PILO***



***POST PILO***



# Management of Adie's Tonic Pupil

- Cholinergic maintenance therapy
- Reading glasses
- Reassurance

# Adie's "Masquerades"

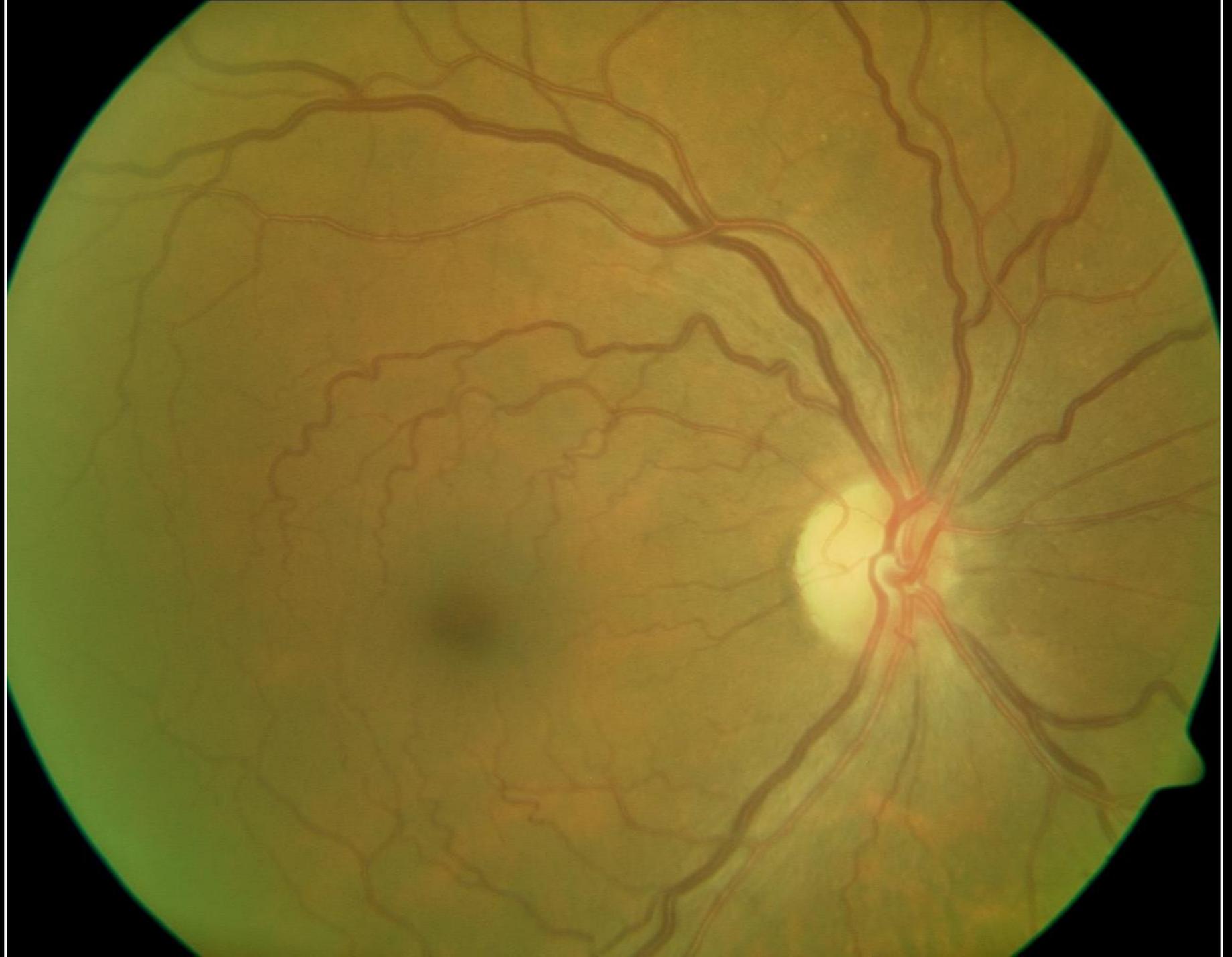
- Syphilis
- Giant-cell Arteritis

*FTA-Abs & ESR/C-reactive protein for atypical cases!!!*

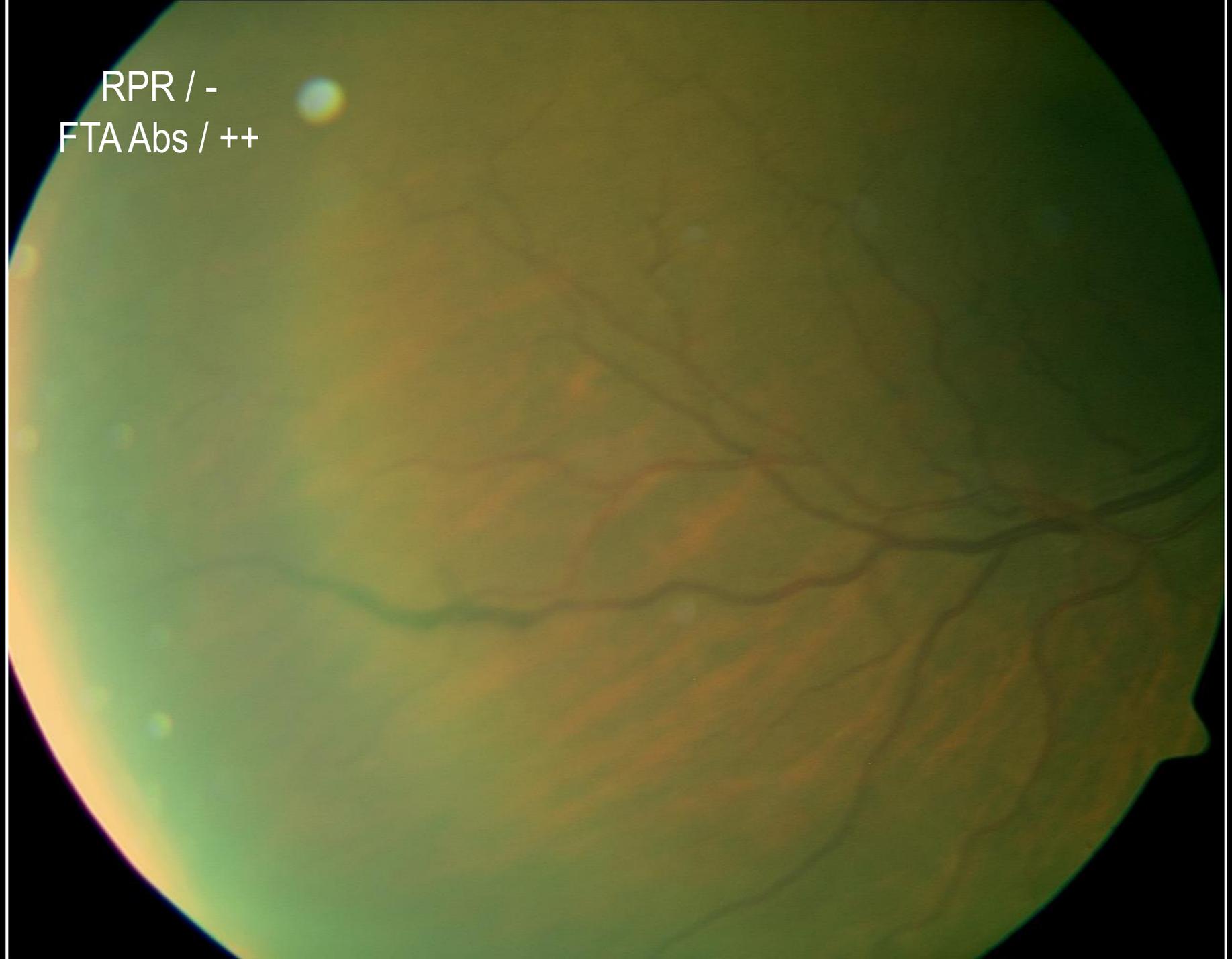
# 72 y/o Woman

- Recent observation of tonic pupils
- BVA:
  - 20/30 OD
  - 20/20 OS



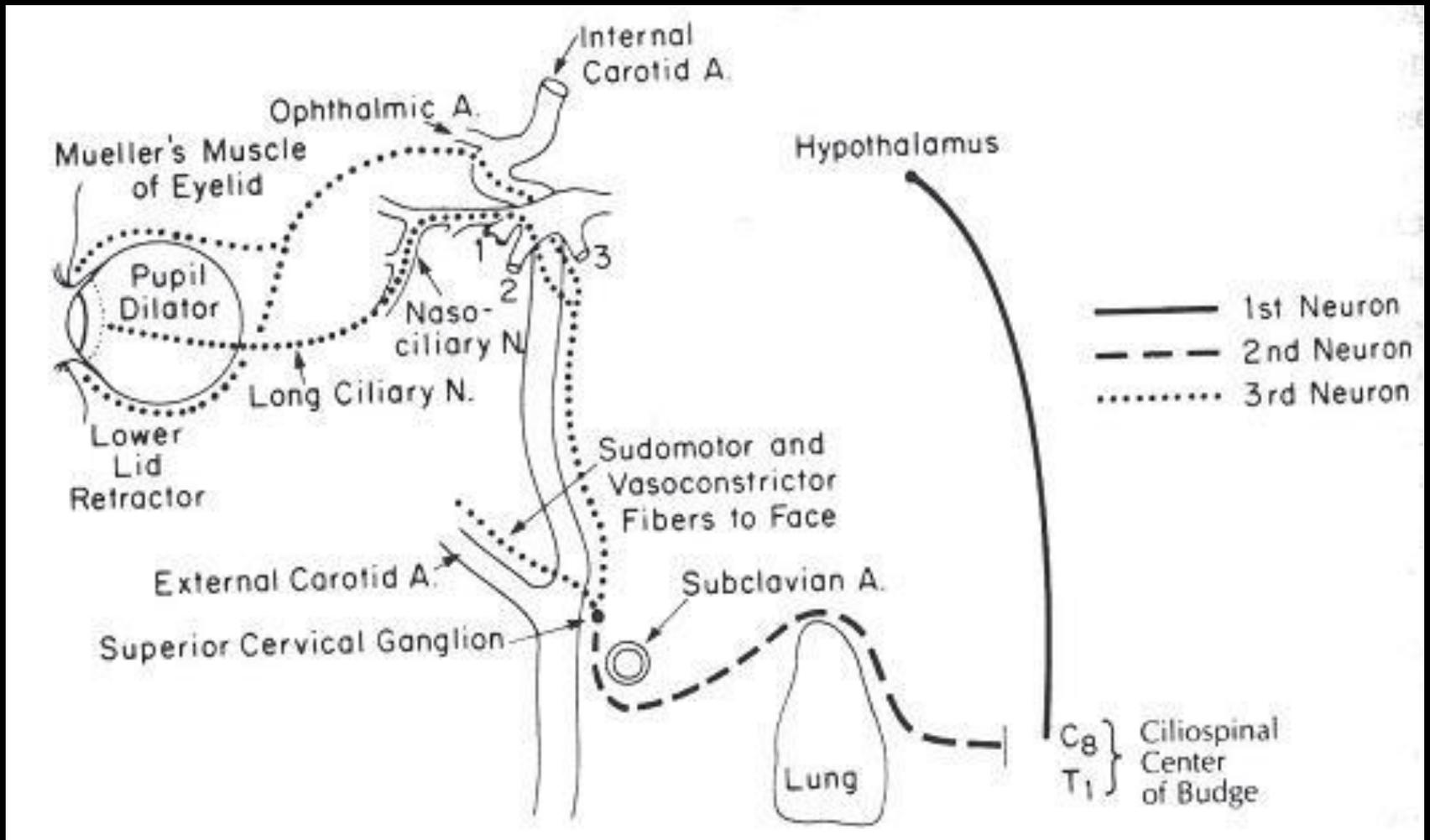


RPR / -  
FTA Abs / ++

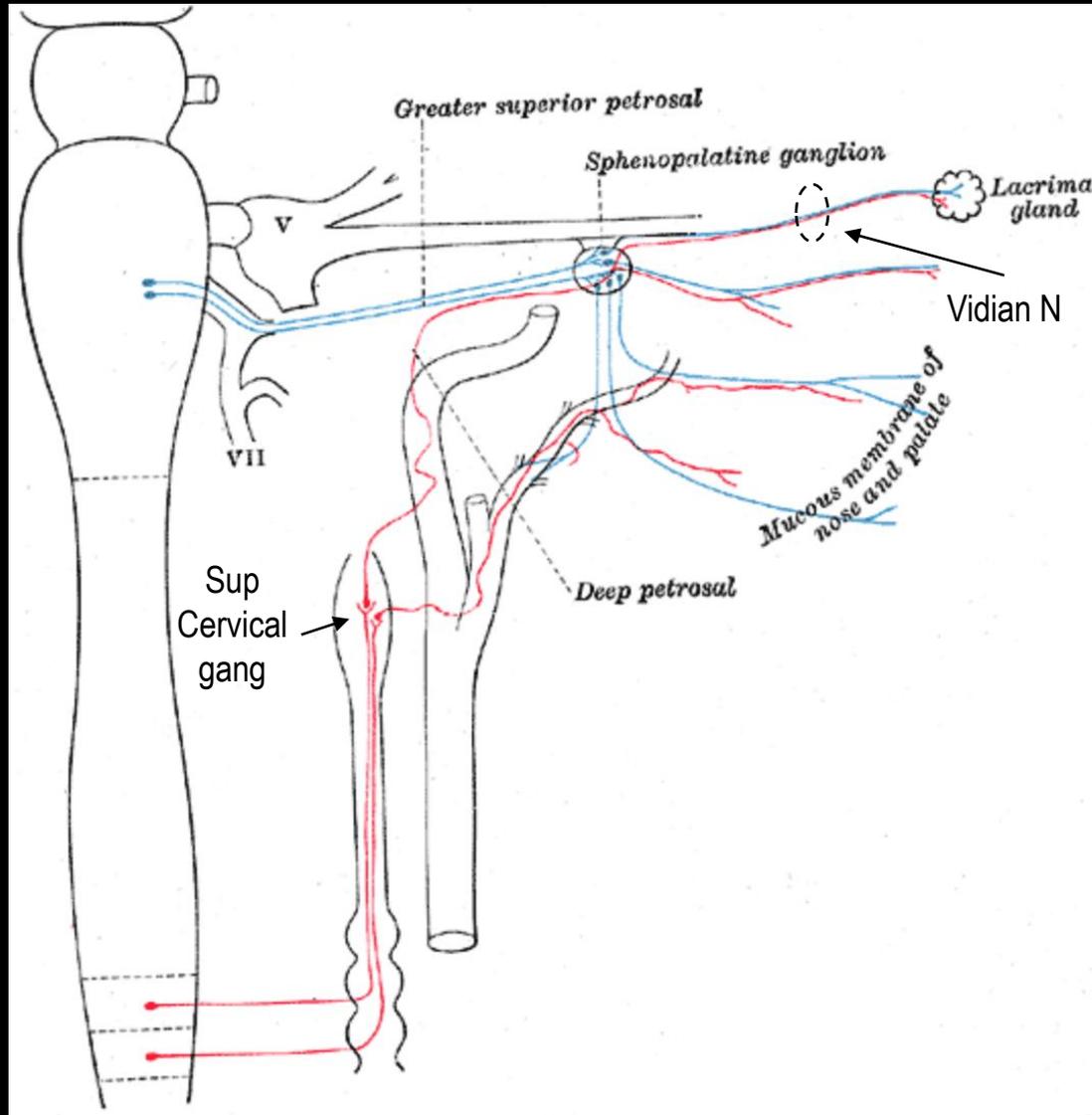


# Oculosympathetic Paresis (Horner Syndrome)

# Efferent Oculosympathetic Pathways

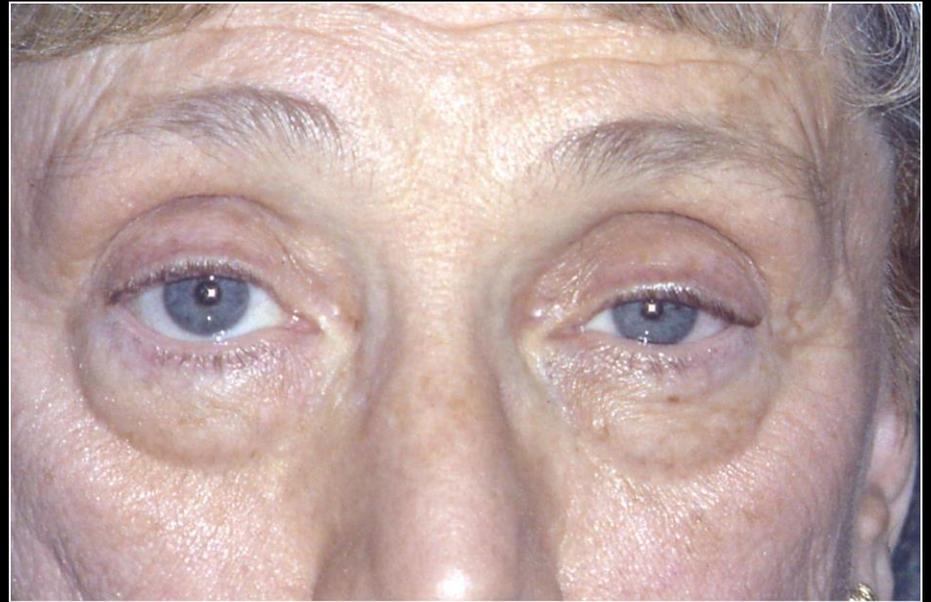


Sympathetic (deep petrosal N) & parasympathetic (greater superficial petrosal N) from sphenopalatine ganglion to lacrimal gland (Vidian N)



# Clinical Features of Horner Syndrome

- Ptosis
- “Pseudo” enophthalmos
- Miosis
- Dilation lag
- Heterochromia irides (congenital/pediatric)
- Decreased lacrimation (Vidian nerve)
- Hemi-facial anhidrosis
  - preganglionic



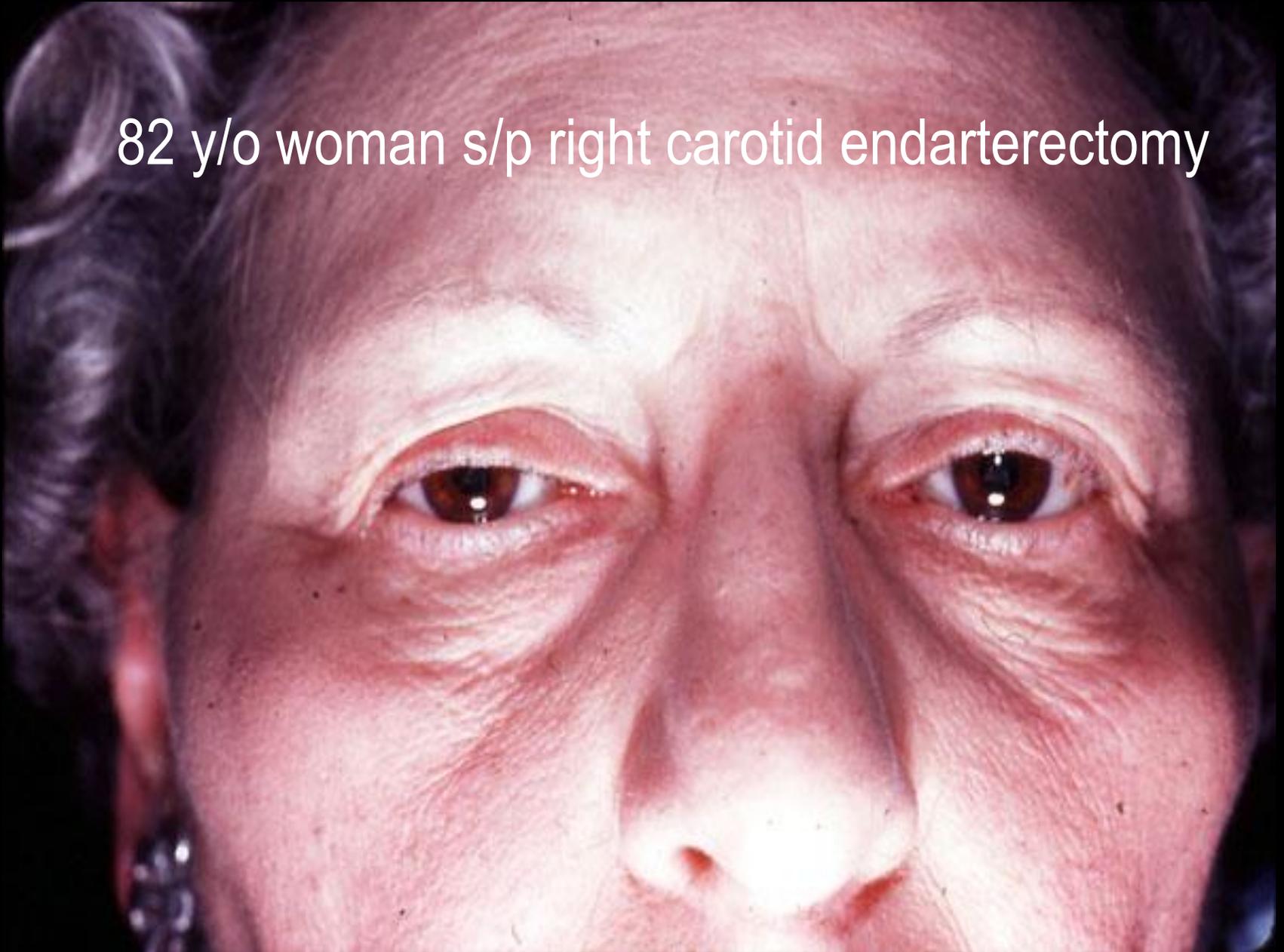
# Oculosympathetic Lesions

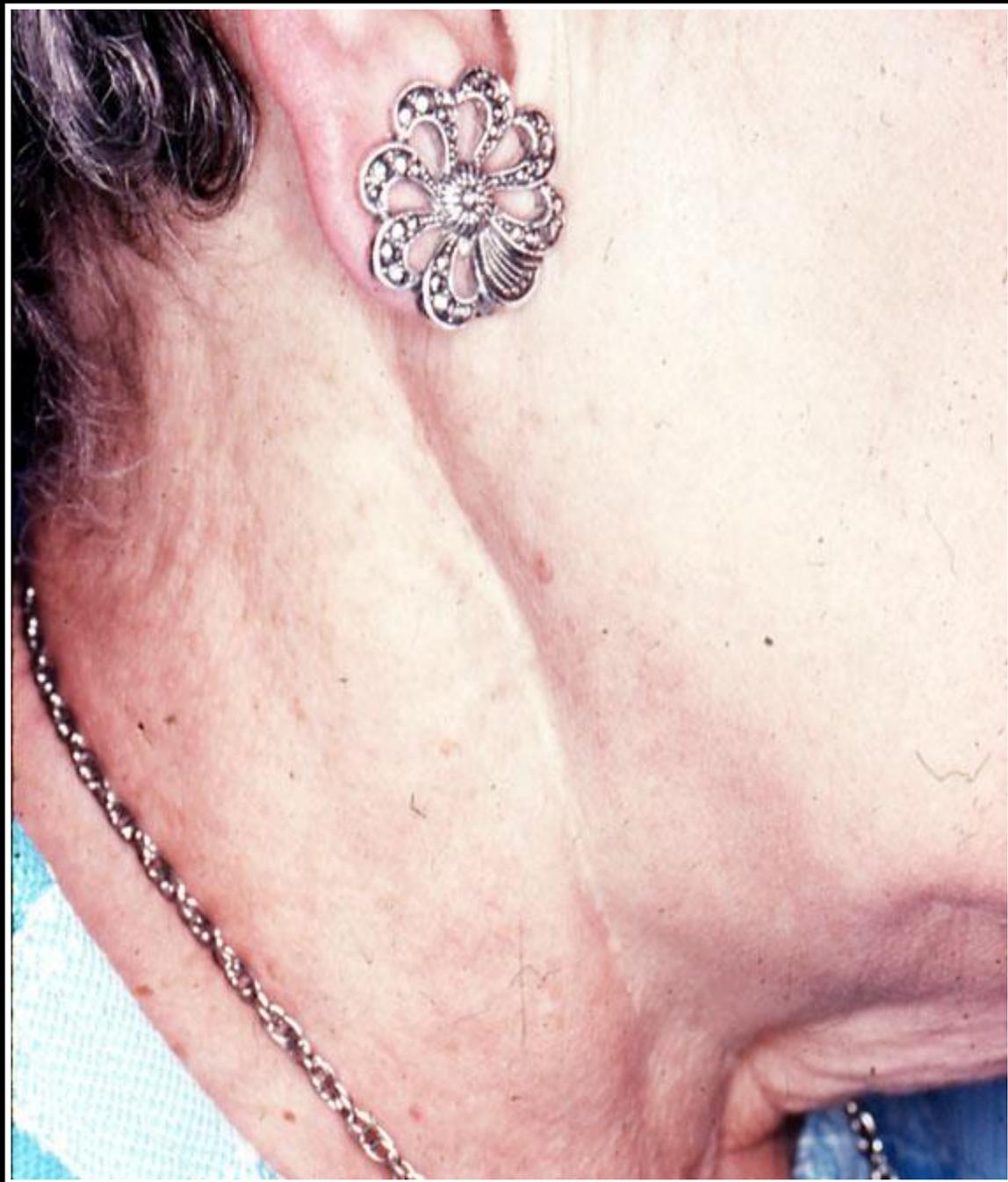
1. First order neuron (central)
2. Second order neuron (pre-ganglionic)
3. Third order neuron (post-ganglionic)

# Common Causes of Horner Syndrome (Neuron & Frequency)

	Common	Uncommon
First-order (central) neuron (10-15%)	Lateral medullary stroke Spinal cord lesion	Hypothalamic, midbrain, or pontine injury
Second-order (preganglionic) neuron (40-45%)	Pancoast tumor Brachial plexus injury Iatrogenic trauma Neuroblastoma	Cervical disc disease
Third-order (postganglionic) neuron (40-45%)	Carotid dissection Carotid thrombosis Cluster headache Cavernous sinus lesion "Small vessel ischemia"	Intraoral trauma

82 y/o woman s/p right carotid endarterectomy





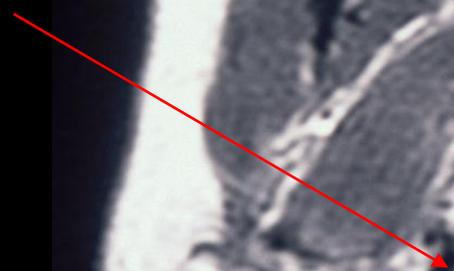
## 37 y/o man

- Hx of recent auto accident with whiplash injury
- Transient monocular blindness, OD
- Right side neck pain with intracranial noise



7  
S20.9

DOB: 16 Dec 1  
24 Feb  
03:59:39  
Mag =  
FL:  
ROT:



00  
0  
/1 15.6kHz  
RAY  
20x20  
nk/1.5sp  
5:40





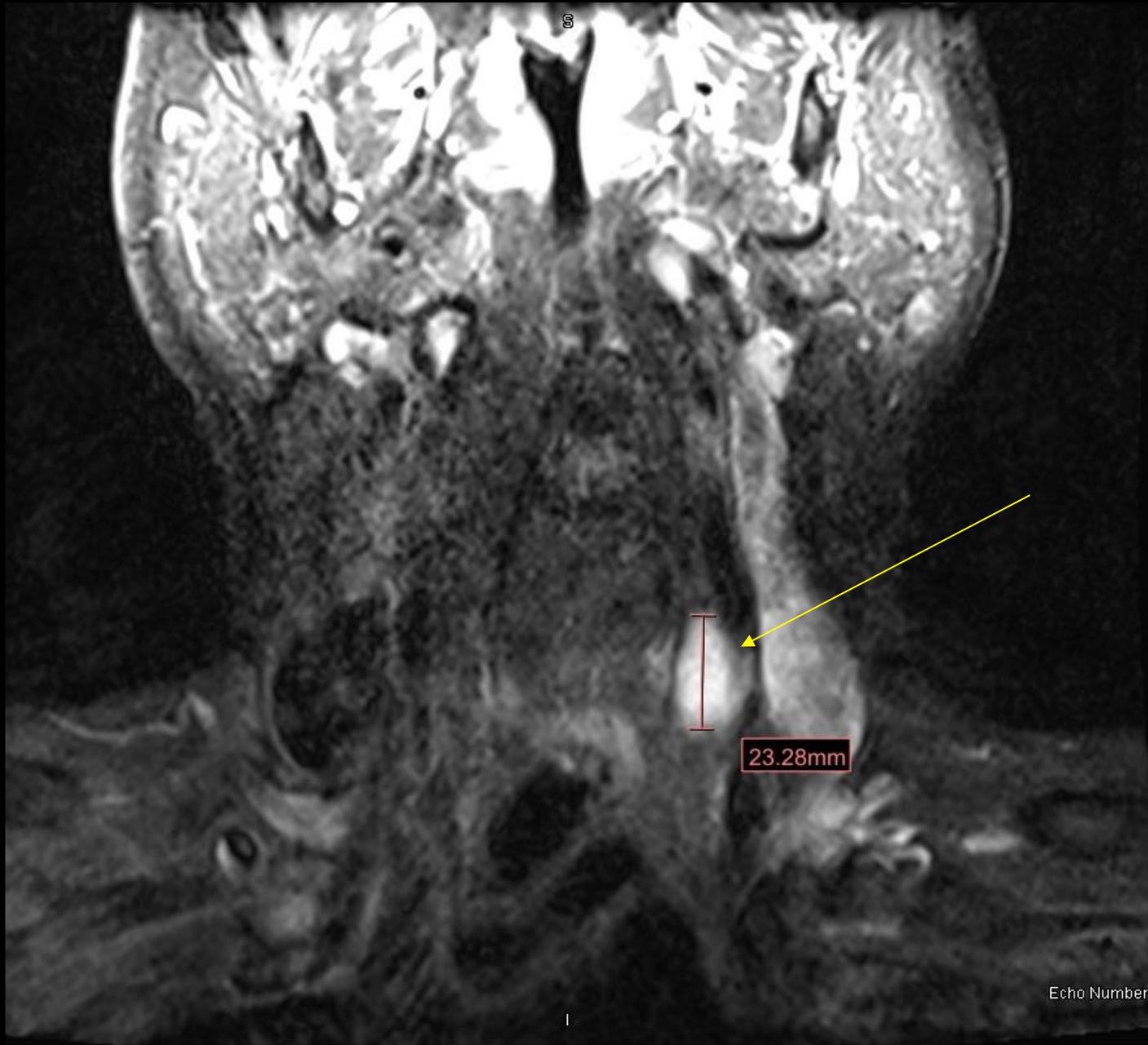
# Emory University Longitudinal Assessment of 146 Cases of Carotid Artery Dissection (1972-1997)

- 91/146 (62%): eye signs/symptoms
- 76/146 (52%): eye signs/symptoms as presenting feature
- 65/146 (44%): painful Horner syndrome
- 41/146 (28%): TMB (31 with pain)
- 27/76 (36%) with initial presenting eye signs suffered a retinal or hemispheric stroke (average 6.2 days)

# 64 y/o man

- Consult for left Horner syndrome
- Left-sided facial anhidrosis
- Persistent hypercalcemia



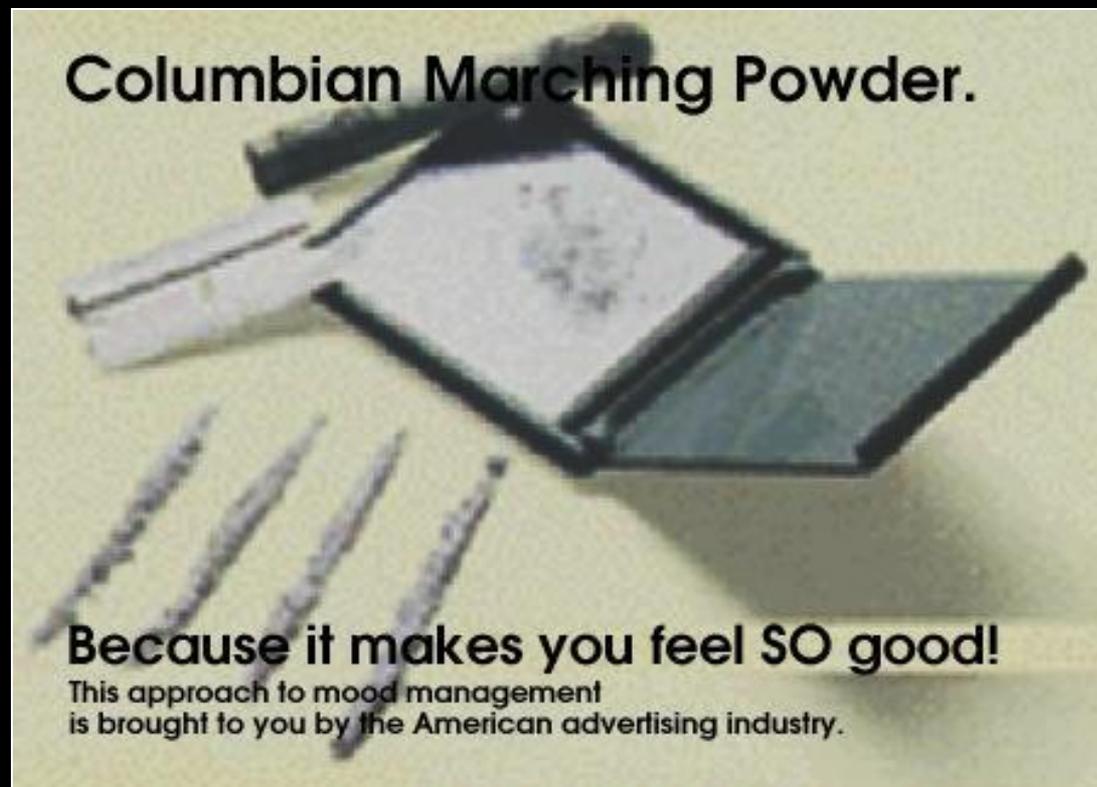


23.28mm

Echo Number



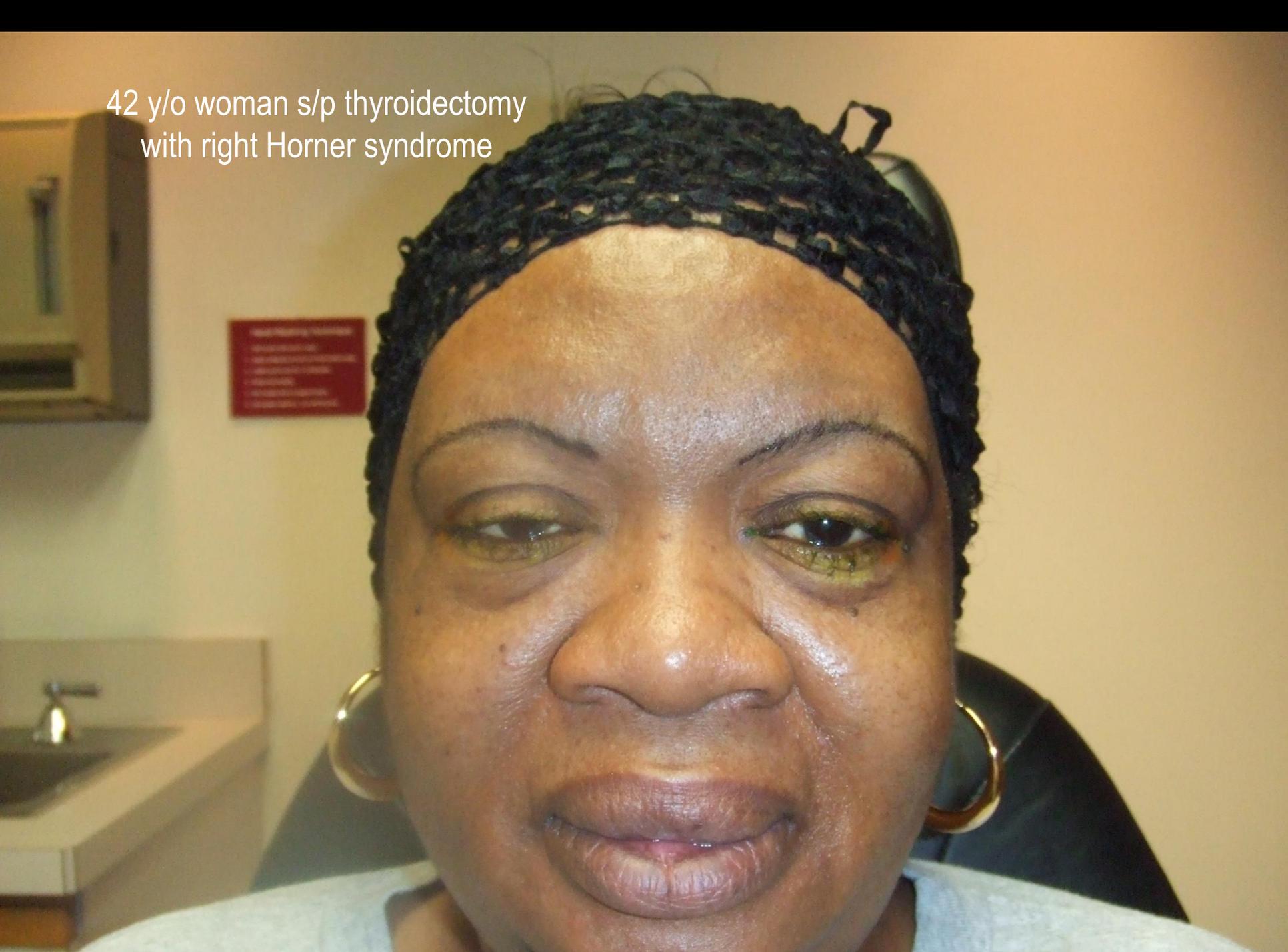
# Pharmacologic Testing for Horner Syndrome



# 0.5% Apraclonidine in the diagnosis of Horner's Syndrome

- Weak alpha-1 agonist /strong alpha-2 agonist
- No dilation / constriction of normal pupil (alpha-2 agonist)
- Dilation of Horner's pupil (alpha-1 agonist - adrenergic denervation supersensitivity)
- “reversal of anisocoria”
- Contraindicated in kids < 2 yrs.

42 y/o woman s/p thyroidectomy  
with right Horner syndrome



Before apraclonidine



After apraclonidine



# Work-up & Imaging for Horner Syndrome

- Adults:
  - If known cause / long-standing: periodic observation
  - If <1 yr. without known etiology:
    - MRI of head, neck, chest
    - MRA of carotids and intracranial vessels

# Work-up & Imaging for Horner Syndrome

- Kids:
  - Rule out neuroblastoma (< 24 months)
  - MRI of head, neck, chest
  - VMA-HVA levels (spot urine testing)

## Infant with Opsoclonus from Neuroblastoma



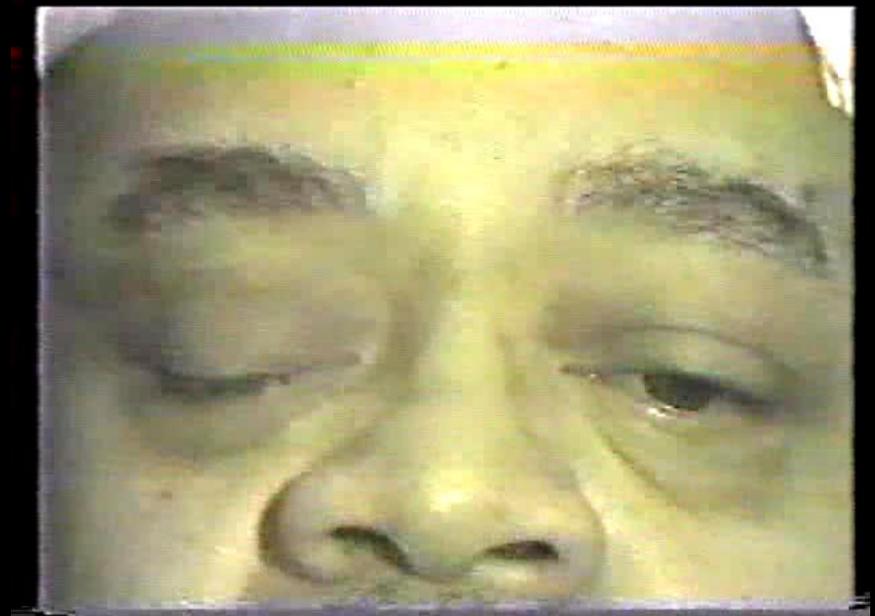
# Third Nerve Palsy

# Signature of CN III Palsy

- Hyperdeviation which increases in up-gaze and **reverses** in down-gaze
- Exo which **increases** across from the vertically limited eye

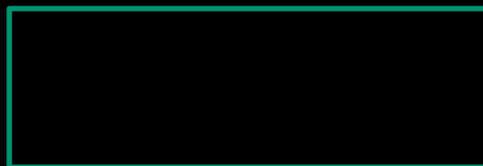
# Pupil Involved CN III Palsy

- 52 y/o man
- Sudden onset painful diplopia
  - Horizontal & vertical
  - Distance & near



1.5T GEMSOW  
Ex: 14694  
PJN  
Se: 123/7  
Im: 5/20  
Sag: L3.9 (COI)

H<sub>p</sub>



Acc: 350907  
2011 Nov 07  
Acq Tm: 09:16:35

512 x 512



ET: 0  
TR: 37.0  
TE: 2.9

1.4thk/0.0sp  
Id:DCM / Lin:DCM / Id:ID  
W:324 L:152

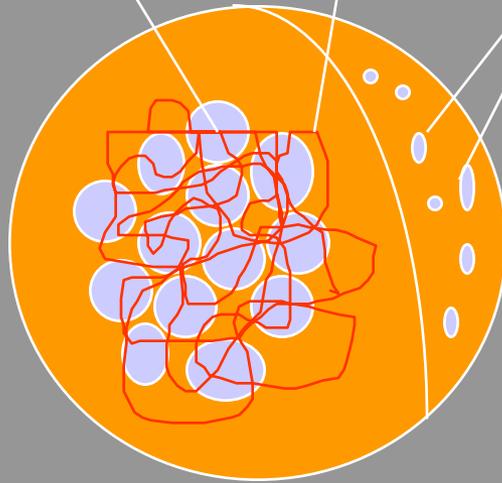
F<sub>A</sub>

DFOV: 14.0 x 14.0cm

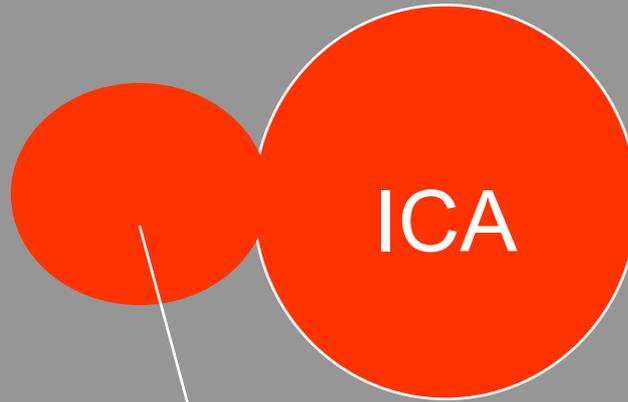
# *Vasonervorum*

EOM Fibers

Pupil Fibers

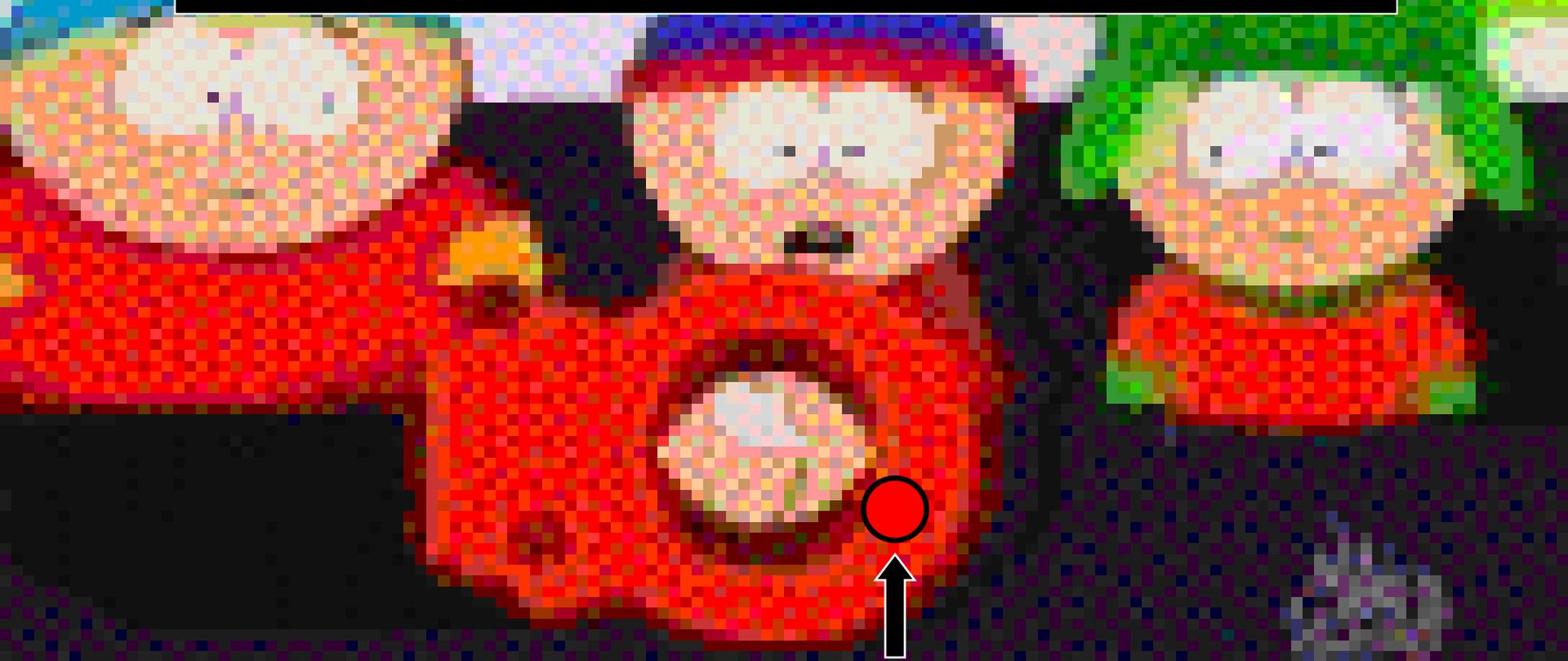


CN III



*Aneurysm*

**20% MORTALITY WITHIN 1 DAY**  
**50% MORTALITY WITHIN 3 WEEKS**  
**30% SURVIVORS with**  
**PERMANENT NEUROLOGIC DISABILITY**



Olafsson E, et al. *Neurology* 1997  
Bhatti TM, et al. *NANOS* 2003

**RUPTURED**  
**ANEURYSM**

# ***“Rule of the Pupil”***

	<b>Pupil Involved</b>	<b>Pupil Spared</b>
<b>Aneurysm</b>	86%	14%
<b>Ischemic / Vascular</b>	23%	77%

Kissel JT, et al. *Ann Neurol* 1983  
Goldstein JE, et al. *Arch Ophthalmol* 1960

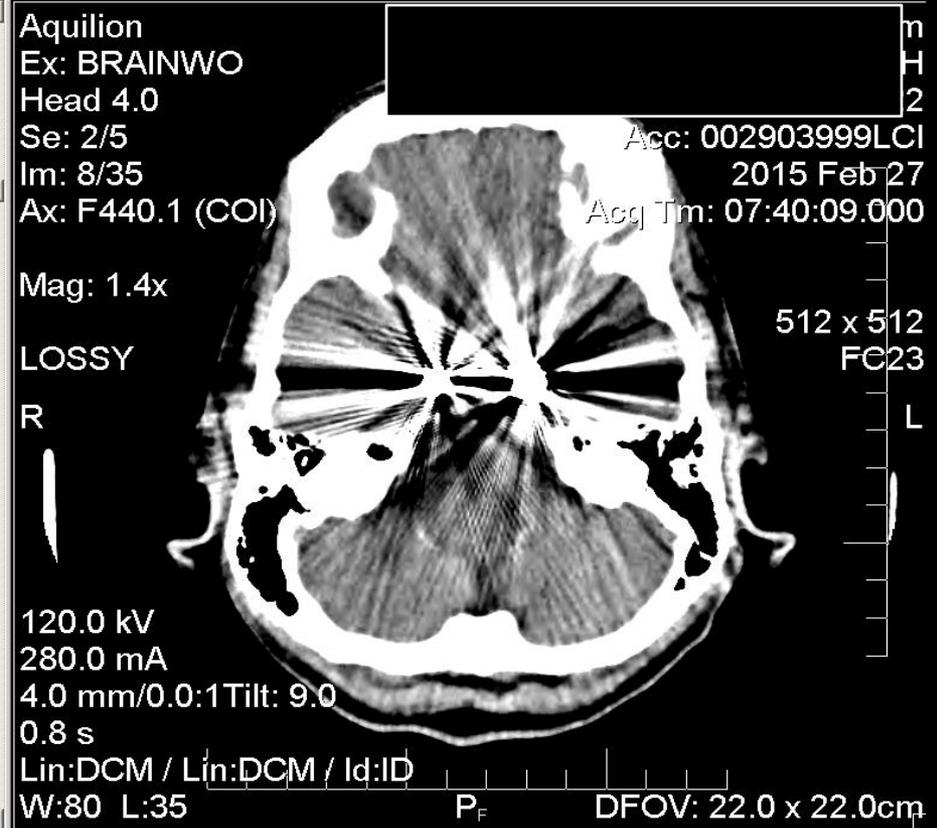
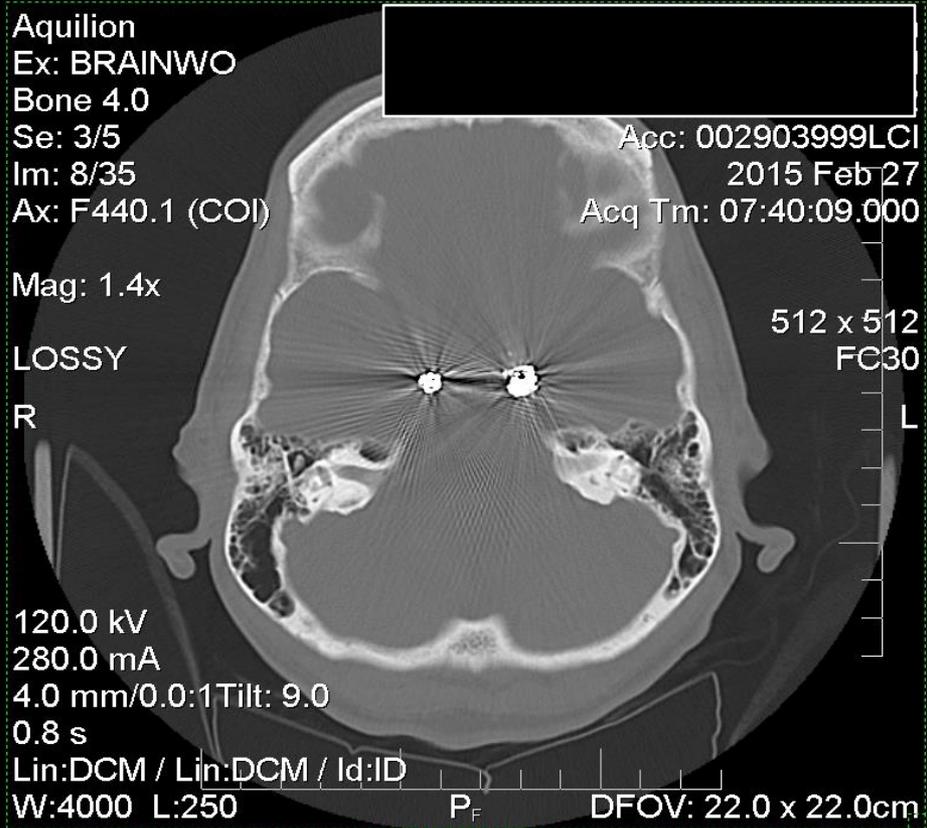
# Neuroimaging for CNIII Palsy (Pupil-Spared)

- MRI / CT of brain
- Cerebral angiography
  - CT Angiography
  - MR Angiography

# Aberrant Regeneration of CN III Palsy

1. Eyelid synkinesia
2. Pseudo Graefe sign
3. Light-near dissociated pupil





Aquilion  
Ex: BRAINWO  
Bone 4.0  
Se: 3/5  
Im: 8/35  
Ax: F440.1 (COI)  
Mag: 1.4x  
LOSSY  
R  
120.0 kV  
280.0 mA  
4.0 mm/0.0:1Tilt: 9.0  
0.8 s  
Lin:DCM / Lin:DCM / Id:ID  
W:4000 L:250

Aquilion  
Ex: BRAINWO  
Head 4.0  
Se: 2/5  
Im: 8/35  
Ax: F440.1 (COI)  
Mag: 1.4x  
LOSSY  
R  
120.0 kV  
280.0 mA  
4.0 mm/0.0:1Tilt: 9.0  
0.8 s  
Lin:DCM / Lin:DCM / Id:ID  
W:80 L:35

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# Key Points

- Pupil testing
- Common pathologic pupillary abnormalities:
  - Afferent pupillary defects
  - Tonic pupils
  - Horner syndrome
  - CNIII palsy

# Thank you!

