

# Diplopia: A Neuro- Ophthalmologic Overview

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# Disclosures

▶ None



# Neuro-Ophthalmology

## ▶ Afferent Disorders

### ▶ Vision loss or changes

- ▶ Unresolving or transient

- ▶ Unilateral versus bilateral

- ▶ Optic neuritis

- ▶ Non-Arteritic Ischemic Optic Neuropathy (NAION)


- ▶ AAION (Temporal Arteritis/GCA)

## ▶ Efferent Disorders

- ▶ Diplopia

- ▶ Ptosis (3<sup>rd</sup> CNP or Horner's)

- ▶ Oscillopsia (nystagmus on exam)

- ▶ Anisocoria (  ICP or Horner's)

# Ocular Motor Deficits

Oculomotor (3<sup>rd</sup> Cranial) Nerve Palsy

Abducens (6<sup>th</sup> Cranial) Nerve Palsy

Trochlear (4<sup>th</sup> Cranial) Nerve Palsy

Internuclear Ophthalmoplegia



# Ocular Motility Review

- ▶ LR6SO4AO3
- ▶ 6th
  - ▶ Lateral Rectus: ABduction
- ▶ 4th
  - ▶ Superior Oblique: Infraduction, incyclotorsion (strongest in ADDuction)
- ▶ 3rd
  - ▶ Superior Rectus: Supraduction and mild incyclotorsion
  - ▶ Inferior Rectus: Infraduction
  - ▶ Medial Rectus: ADDuction
  - ▶ Inferior Oblique: Supraduction, Excyclotorsion (strongest in ABduction)
  - ▶ Levator palpebrae: Elevates the lid
    - ▶ Inferior Division → pupillary constriction

# Third Cranial Nerve Palsy

- ▶ Patient: Diplopia +/- Ptosis +/- Anisocoria
- ▶ History: Acuity, Painless versus Painful, Trauma
- ▶ Clinical examination: Complete or Incomplete? Pupil involvement?

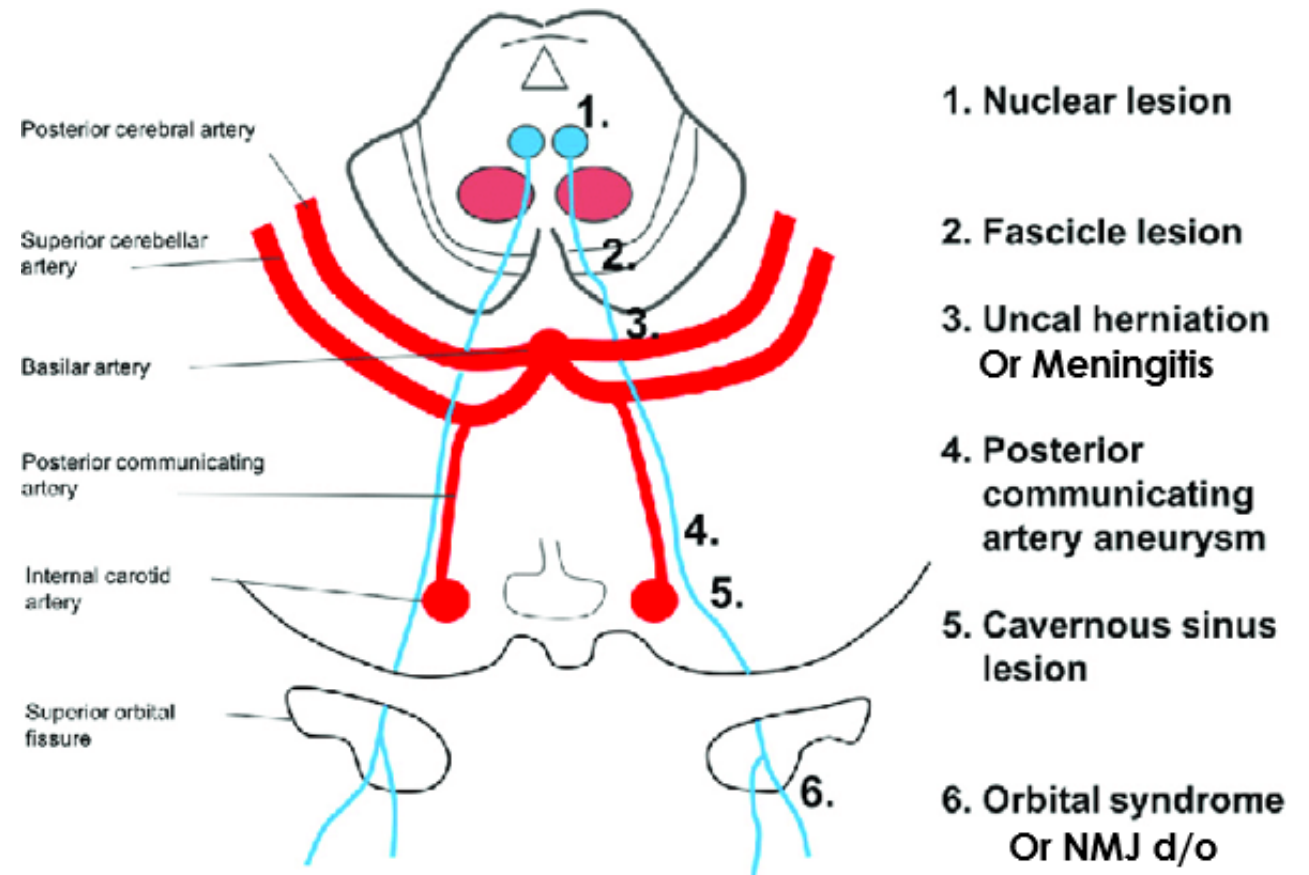
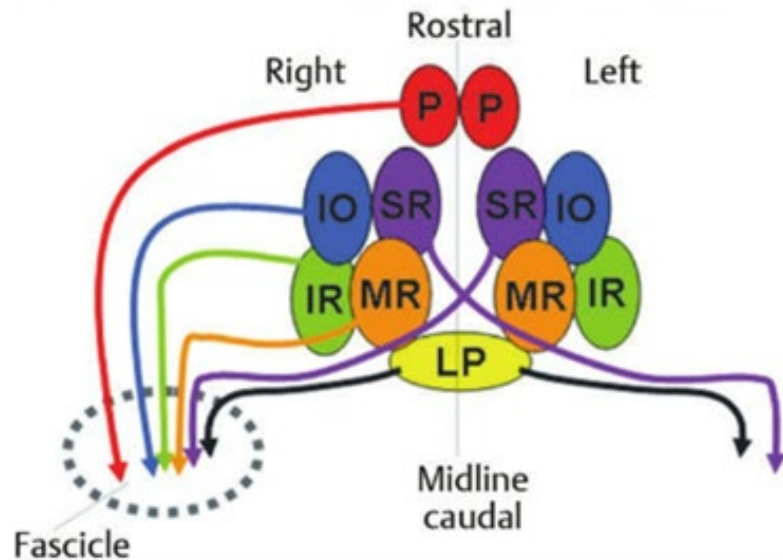


Balcer LJ, et al. Am J Ophthalmol 1996; 122:437



# Oculomotor Nerve Anatomy

P: Parasympathetic (Edinger Westphal nucleus)  
 LP: Levator palpebrae (central caudal nucleus)  
 IO: Inferior oblique  
 IR: Inferior rectus  
 SR: Superior rectus  
 MR: Medial rectus



# Third Cranial Nerve Palsy Loci

Nuclear Lesion

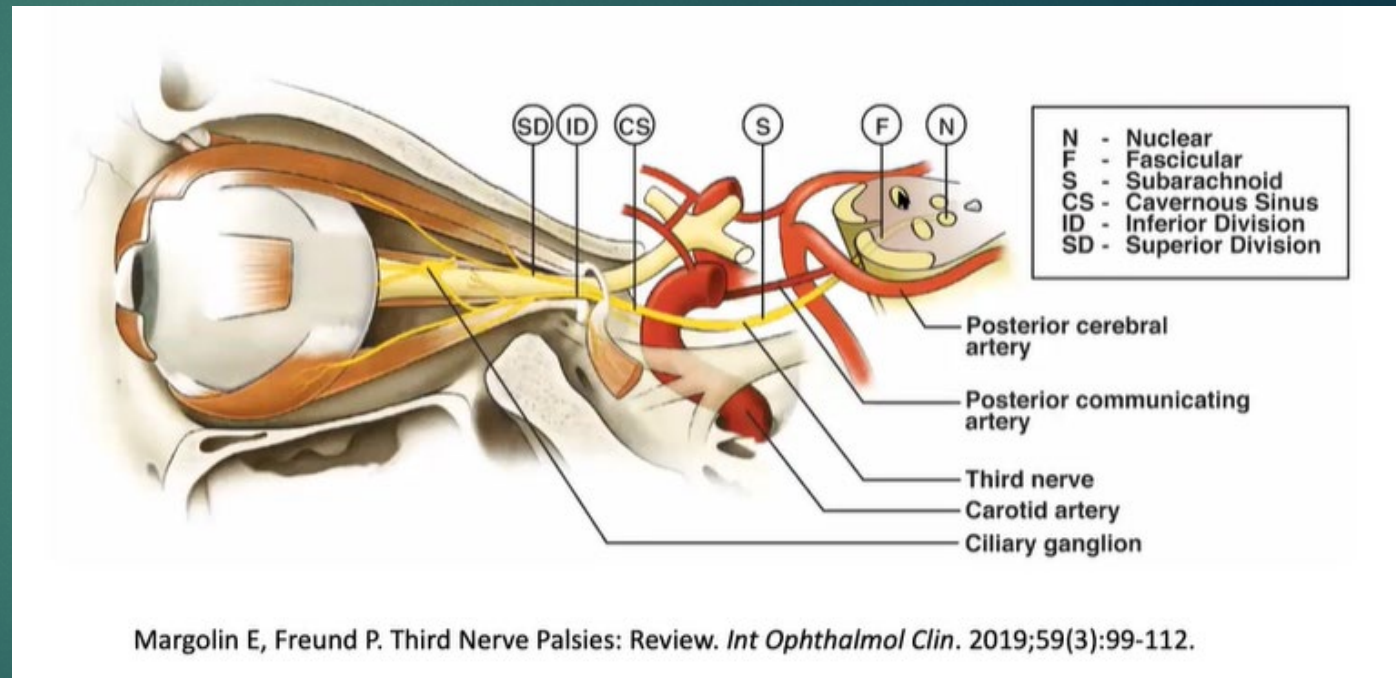
Fascicular Lesion

Uncal  
Herniation or  
Meningitis

Aneurysmal  
compression  
(SCA or PCOM)

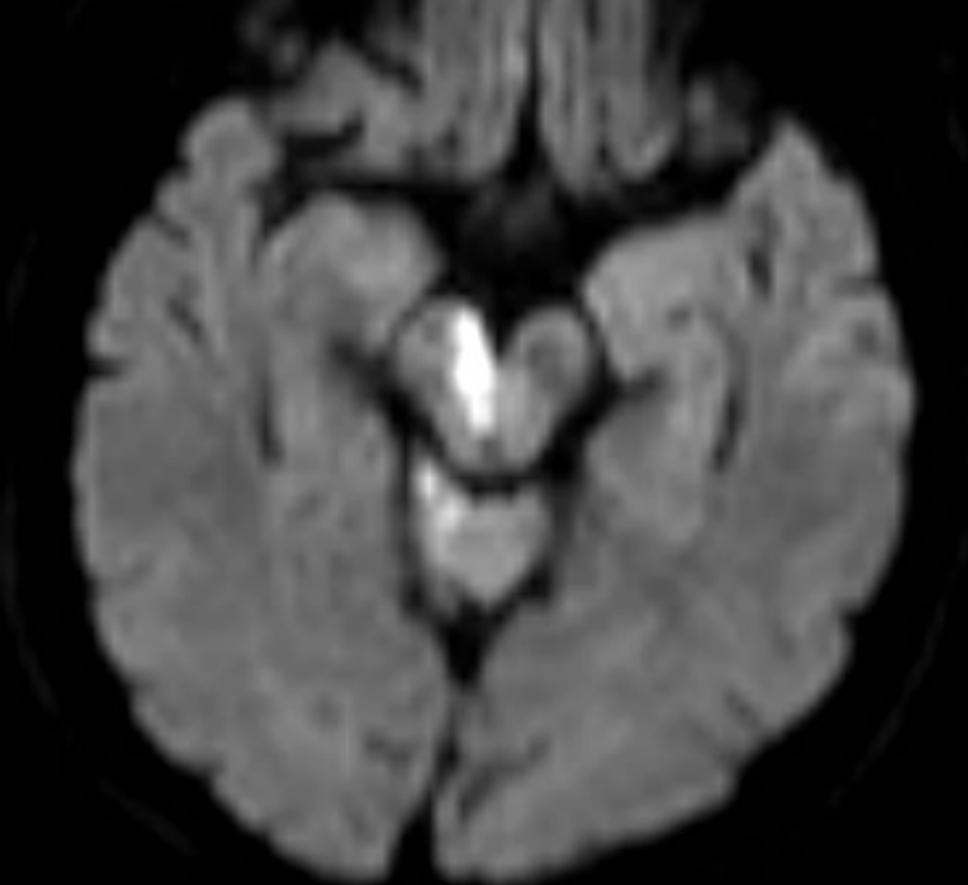
Cavernous  
Sinus Lesion

Orbital Lesion  
or NMJ

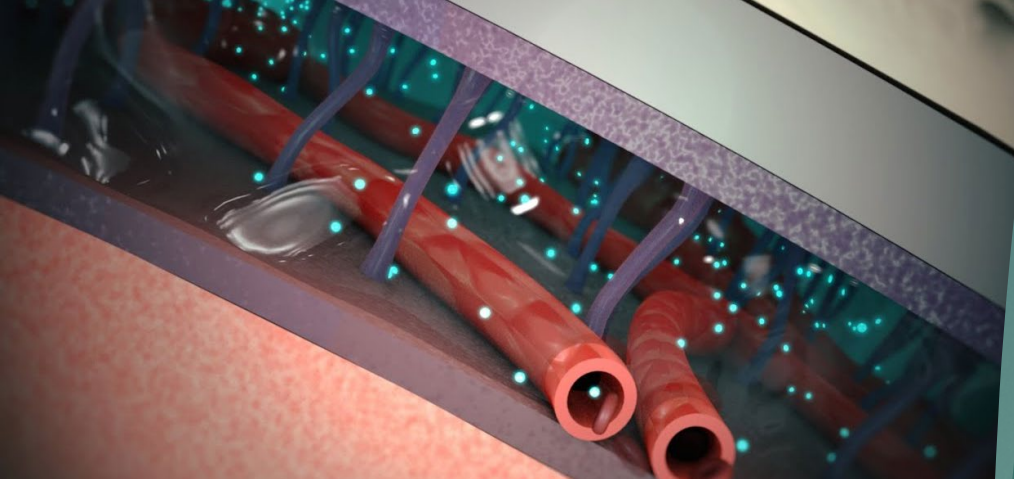




# Nuclear or Fascicular Lesion



- ▶ Etiologies
  - ▶ Stroke
  - ▶ Demyelination
  - ▶ Hemorrhage
  - ▶ Vascular malformation
  - ▶ Tumor
  - ▶ Temporal Arteritis
  - ▶ Pituitary Apoplexy
- ▶ Testing
  - ▶ **MRI w/wo**
  - ▶ **MRA brain**
  - ▶ **ESR, CRP, CBC for platelets**



# Uncal Herniation or Meningitis

- ▶ Uncal Herniation → **CTH**
  - ▶ Cushing's triad
    - ▶ HTN
    - ▶ Bradycardia
    - ▶ Apnea/irregular breathing
  - ▶ Headache
  - ▶ AMS
  - ▶ N/V
- ▶ Meningitis → **MRI brain w/wo**
  - ▶ Fever
  - ▶ Headache
  - ▶ Vomiting
  - ▶ Nuchal Rigidity

▶ Tintinalli JE, et al: Emergency Medicine: A Comprehensive Study Guide. 3rd ed. New York: McGraw-Hill; 1992.

▶ Meningitis / Brain Injury caused by infection / Causes - Disorders | [Braininjury-explanation.com](http://Braininjury-explanation.com)

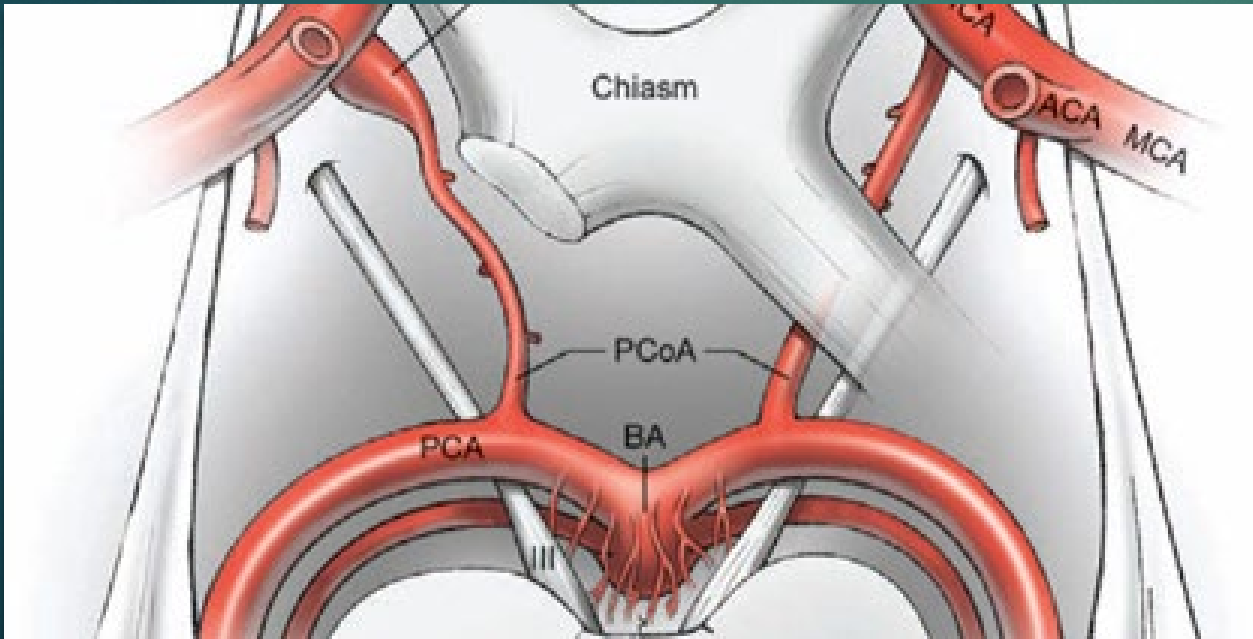


# Aneurysmal compression (SCA or PCOM)

- Parasympathetics superficial → pupillary involvement

BUT normal pupillary function does not rule out aneurysm!

MUST obtain vessel imaging **CTA or MRA** brain!



# Cavernous Sinus Lesion

Testing? MRI brain and orbits w/wo

## Contents

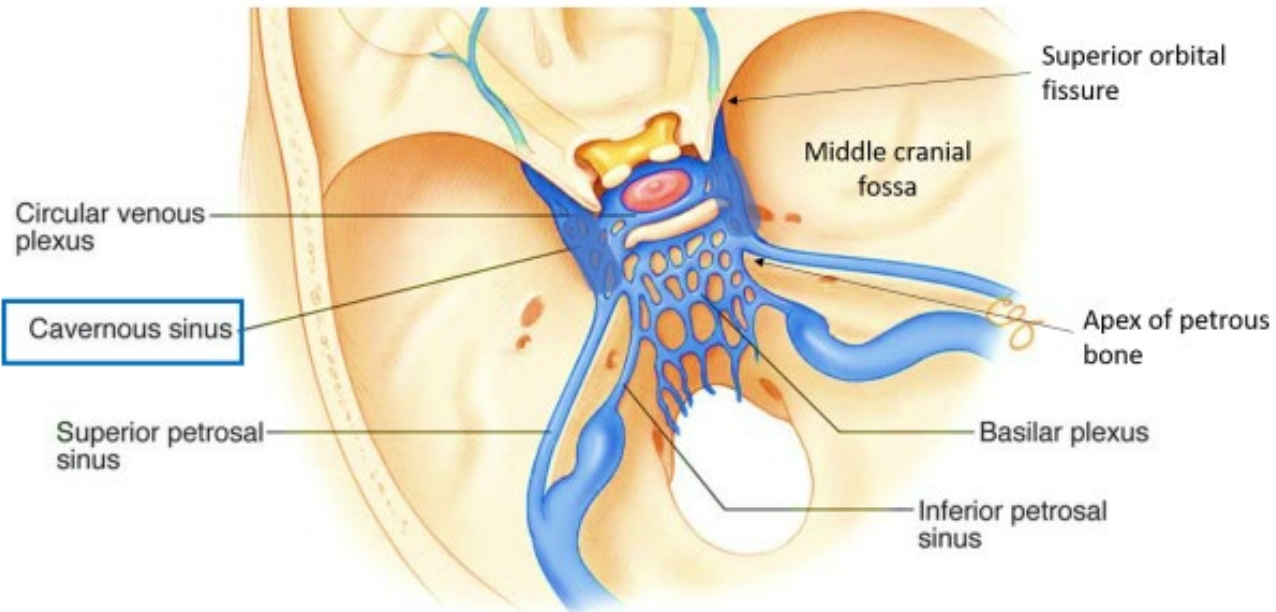
- 3<sup>rd</sup>, 4<sup>th</sup>, and 6<sup>th</sup> CN
- V1 and V2 of Trigeminal
- ICA

## Symptoms

- Eye pain, papilledema, exophthalmos, ophthalmoplegia, ptosis, pupillary dysfunction, facial anesthesia/paresthesia

## Etiologies

- Thrombosis
- Inflammation/Infection
- Carotido-cavernous fistula
- Pituitary apoplexy/mass





- ▶ Superior Orbital Fissure: 3<sup>rd</sup>, 4<sup>th</sup>, 6<sup>th</sup>, V1
- ▶ Superior Division
  - ▶ Levator and superior rectus → ptosis and impaired supraduction
- ▶ Orbital Apex
  - ▶ Proptosis, vision loss, injection
- ▶ Neuromuscular Junction: Any Pattern!
  - ▶ Myasthenia Gravis/LEMS
  - ▶ Fluctuating with fatigue
  - ▶ +/- dysphagia, respiratory or proximal muscle weakness

Orbital Lesion  
or NMJ

# 3<sup>rd</sup> Nerve Palsy Testing

Funduscopy Exam

CTA head

MRI brain and orbits w/wo contrast

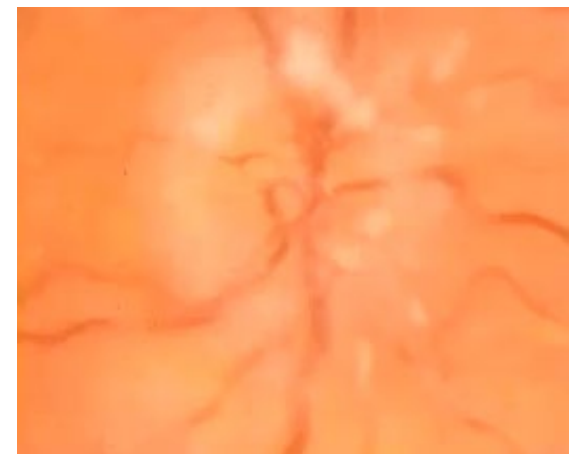
+/- Myasthenia Panel

+/- LP



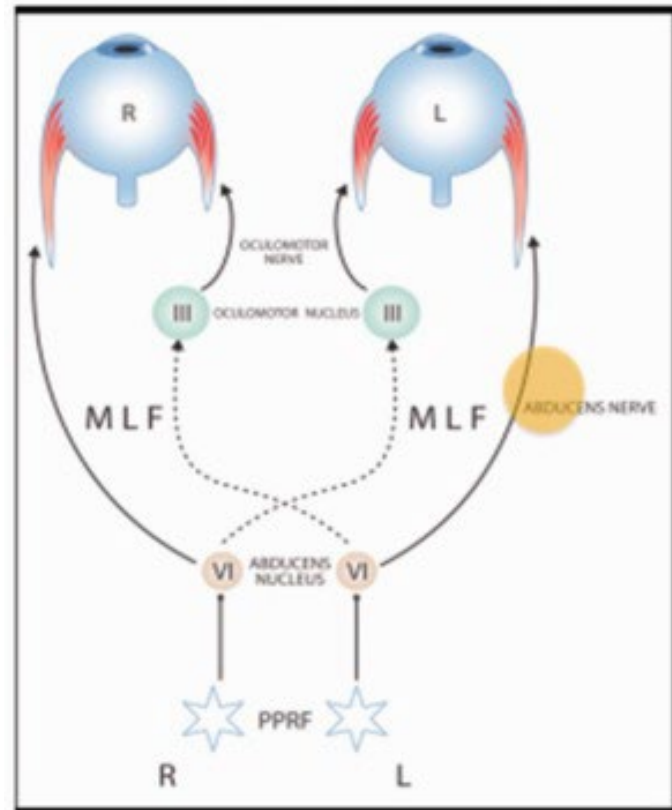
# 6<sup>TH</sup> Cranial Nerve Palsy

- ▶ Inability to ABduct the eye
- ▶ Esotropia
- ▶ Company it keeps!
  - ▶ Papilledema, AMS, headache
  - ▶ Facial Palsy
  - ▶ Other eye movement deficits

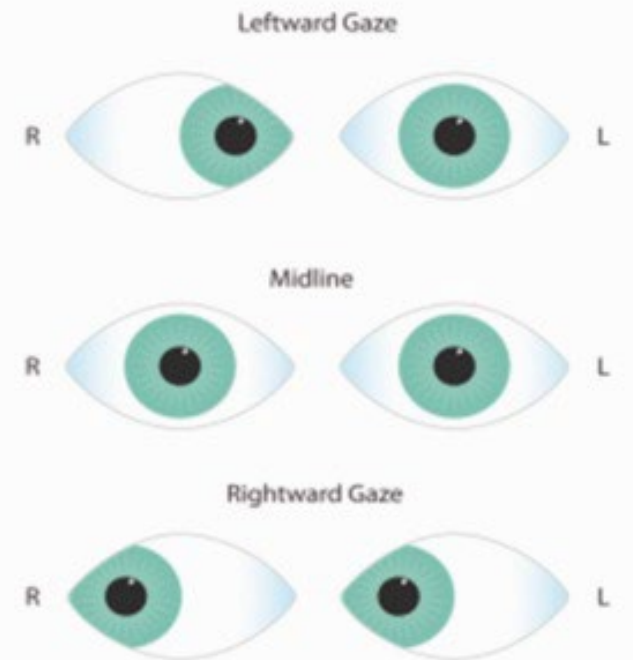


# 6<sup>th</sup> Nerve Palsy: Nucleus versus Fascicle

- ▶ Nucleus
  - ▶ Lateral Gaze Palsy (BOTH EYES)
- ▶ Fascicle
  - ▶ Impaired ipsilateral ABduction



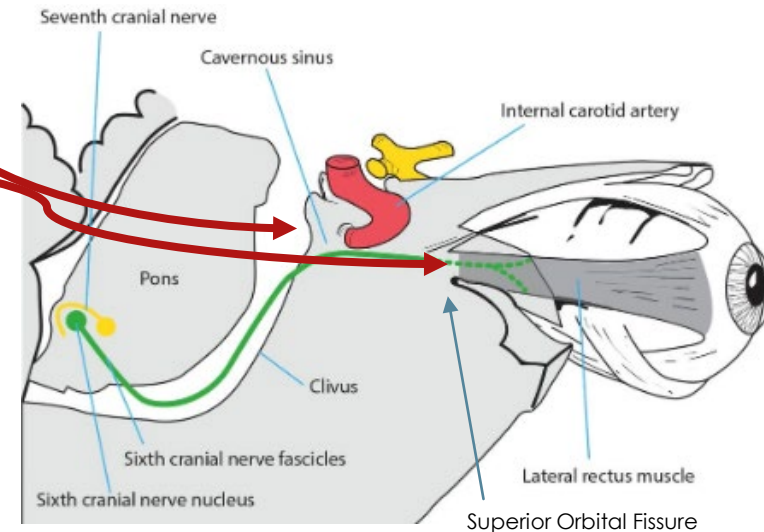
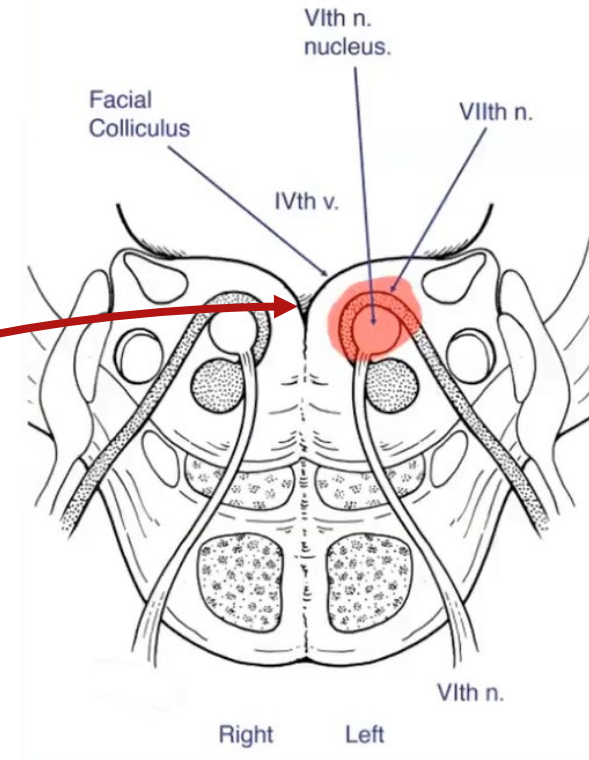
## LEFT ABDUCENS NERVE PALSY





# 6<sup>th</sup> Cranial Nerve Palsy

- ▶ Company it keeps!
  - ▶ Facial Palsy
  - ▶ 1 and a ½ syndrome
  - ▶ 3<sup>rd</sup>, 4<sup>th</sup>, V1 and V2
  - ▶ 3<sup>rd</sup>, 4<sup>th</sup>, and V1 only



# 6<sup>th</sup> CNP Testing



Funduscopic  
Exam



MRI brain w/wo  
contrast



CTH first if  
headache, AMS,  
papilledema



ESR, CRP, CBC if  
GCA symptoms



# 4<sup>th</sup> Cranial Nerve Palsy

- ▶ Complaint
  - ▶ Binocular vertical diplopia, TILT of second image, worse in down and contralateral gaze
- ▶ Exam
  - ▶ Contralateral Head tilt
  - ▶ Hypertropia
  - ▶ Compensatory head tilt
- ▶ History
  - ▶ Head Trauma (even remote)
  - ▶ Headache/fever
  - ▶ Demyelination episodes

# Left 4<sup>th</sup> Cranial Nerve Palsy Exam



Left Hypertropia



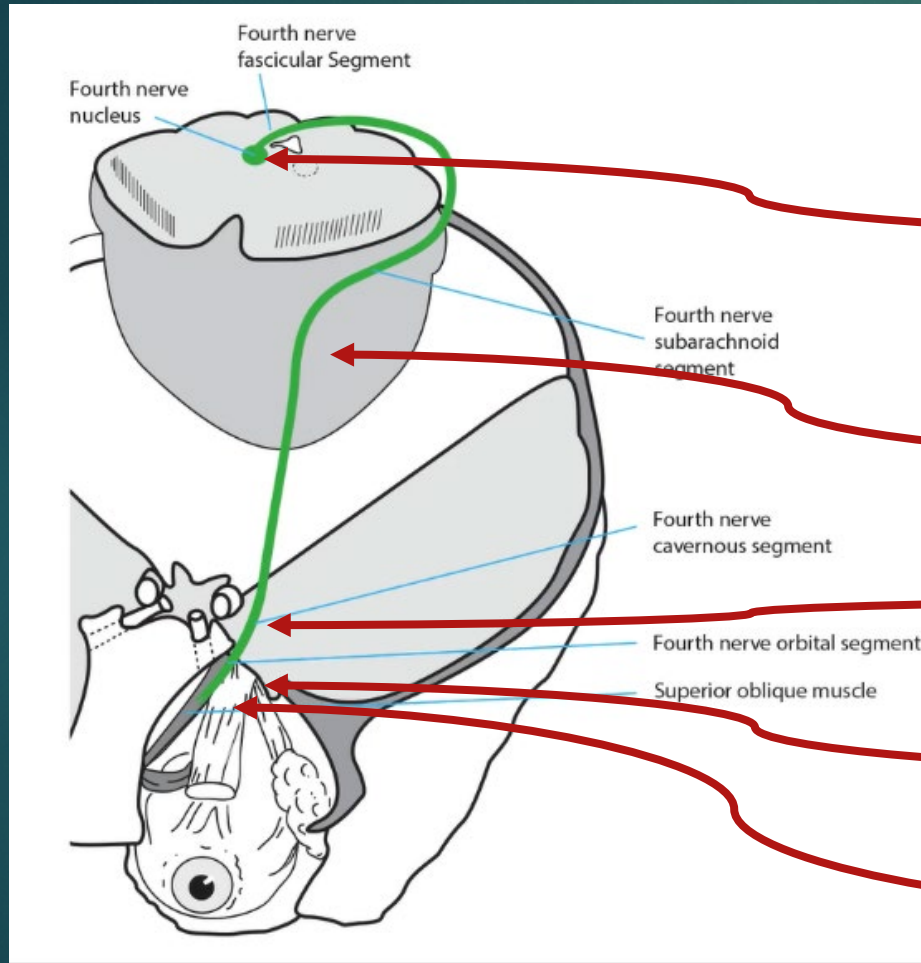
Contralateral head tilt and chin down posture helps!



Superior rectus TRYING to incyclotort the eye but just elevating it

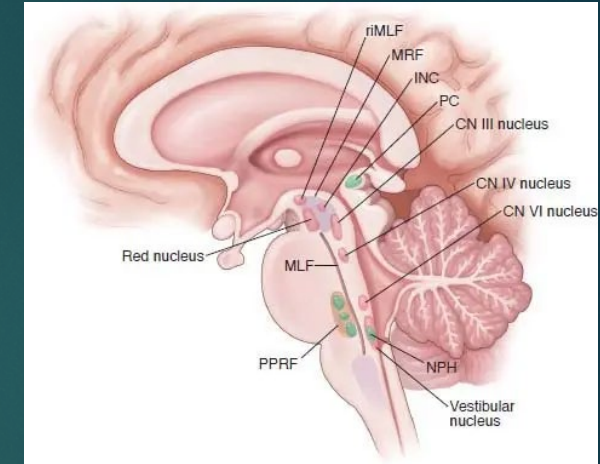
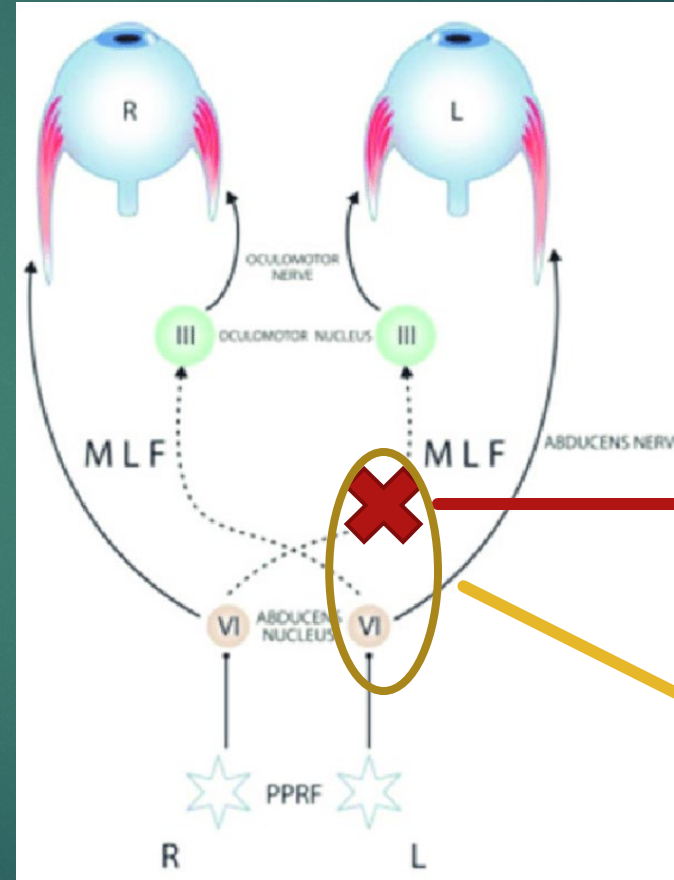
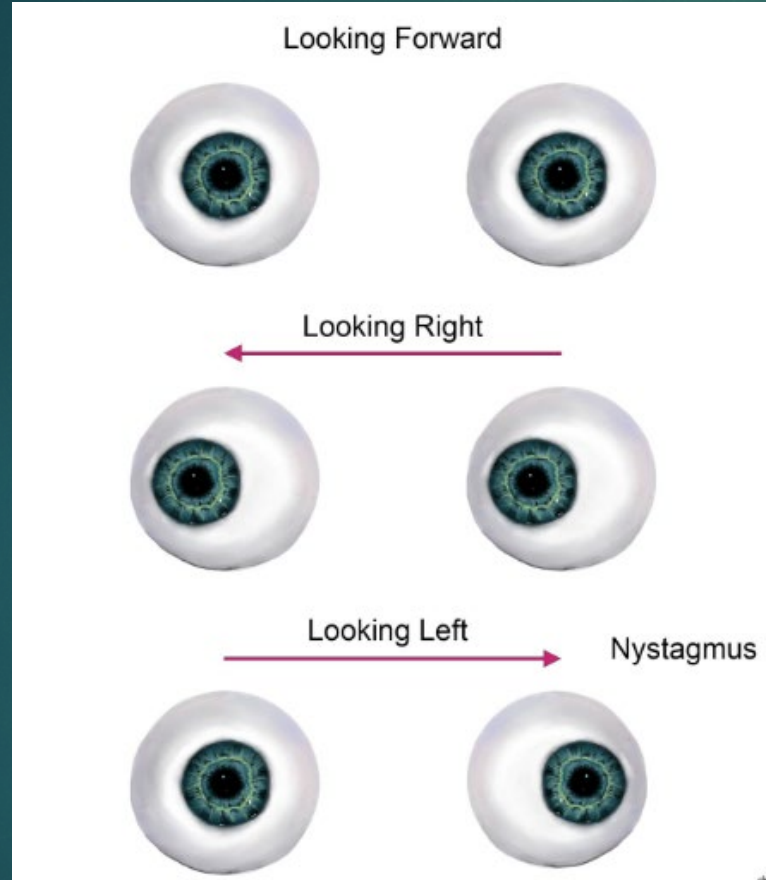


# 4<sup>th</sup> Cranial Nerve Anatomy

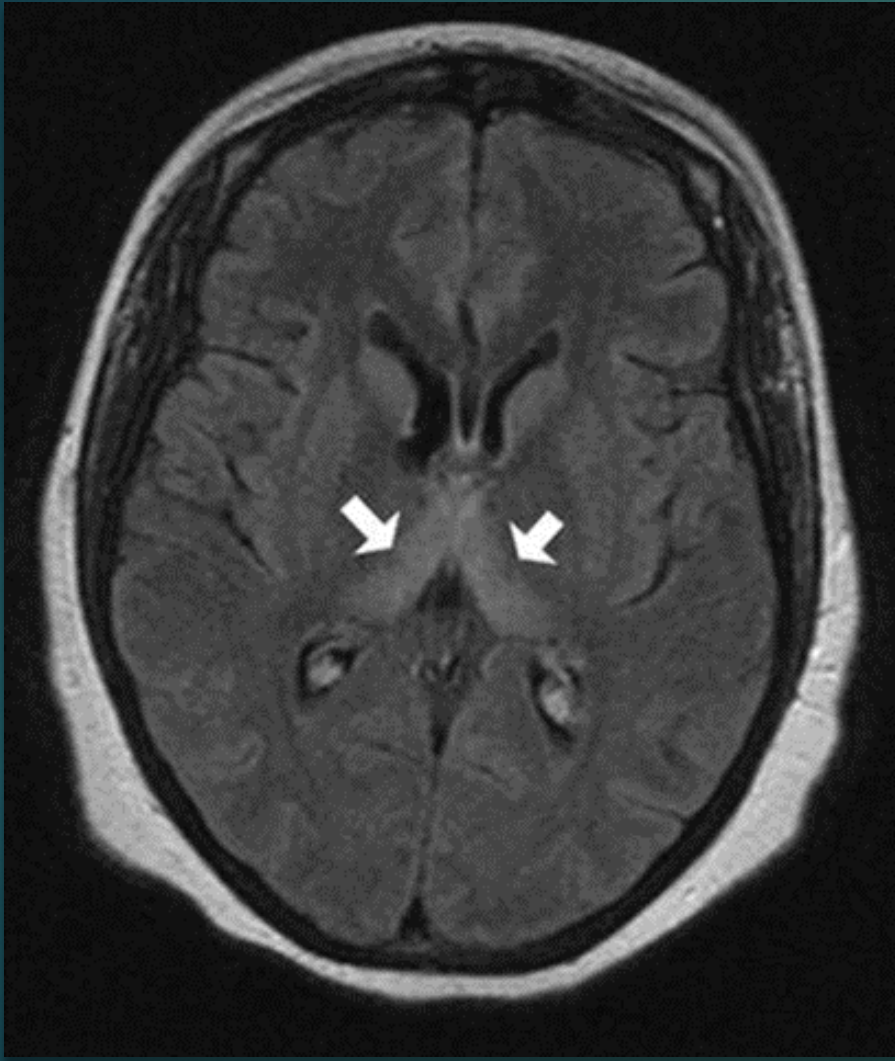


- Crosses and exits dorsally
- Long pathway and fragile
- Company it keeps
  - Nuclear
    - Contralateral brainstem signs
    - Contralateral Horner's
  - Subarachnoid space
    - Diffuse CN involvement
  - Cavernous Sinus
    - 3<sup>rd</sup>, 6<sup>th</sup>, V1/V2, Ipsilat Horner's
  - Superior Orbital Fissure
    - 3<sup>rd</sup>, 6<sup>th</sup>, and V1
  - NMJ
    - s/sx of Myasthenia

# Internuclear Ophthalmoplegia (INO)







# Wernicke Encephalopathy

- ▶ Triad
  - ▶ Confusion
  - ▶ Ophthalmoplegia
  - ▶ Ataxia
- ▶ Exam
  - ▶ Nystagmus
  - ▶ Unilateral or bilateral 6<sup>th</sup> CNP
- ▶ Imaging: MRI brain
- ▶ Treatment: IV thiamine



# Resources

- ▶ Rucker, J.C., Calix, R. (2021). Diplopia, Third Nerve Palsies, and Sixth Nerve Palsies. In: Roos, K.L. (eds) Emergency Neurology. Springer, Cham. [https://doi.org/10.1007/978-3-030-75778-6\\_6](https://doi.org/10.1007/978-3-030-75778-6_6)
- ▶ Miller NR, Newman NJ, Biouesse V, Kerrison JB. Walsh & Hoyt's clinical neuro-ophthalmology. 6th ed. Philadelphia: Lippincott Williams & Wilkins; 2005.
- ▶ Leigh RJ, Zee DS. The neurology of eye movements. 4th ed. New York: Oxford University Press; 2006.
- ▶ Rucker CW. The causes of paralysis of the third, fourth and sixth cranial nerves. Am J Ophthalmol. 1966;61(5 Pt 2):1293–8.
- ▶ Rush JA, Younge BR. Paralysis of cranial nerves III, IV, and VI. Cause and prognosis in 1,000 cases. Arch Ophthalmol. 1981;99(1):76–9.
- ▶ Rucker CW. Paralysis of the third, fourth and sixth cranial nerves. Am J Ophthalmol. 1958;46(6):787–94.
- ▶ Park UC, Kim SJ, Hwang JM, Yu YS. Clinical features and natural history of acquired third, fourth, and sixth cranial nerve palsy. Eye. 2008;22(5):691–6.
- ▶ Soni SR. Aneurysms of the posterior communicating artery and oculomotor paresis. J Neurol Neurosurg Psychiatr. 1974;37(4):475–84.
- ▶ Kissel JT, Burde RM, Klingele TG, Zeiger HE. Pupil-sparing oculomotor palsies with internal carotid-posterior communicating artery aneurysms. Ann Neurol. 1983;13(2):149–54.
- ▶ Ksiazek SM, Repka MX, Maguire A, et al. Divisional oculomotor nerve paresis caused by intrinsic brainstem disease. Ann Neurol. 1989;26:714–8.
- ▶ Bhatti MT, Eisenschenk S, Roper SN, Guy JR. Superior divisional third cranial nerve paresis: clinical and anatomical observations of 2 unique cases. Arch Neurol. 2006;63:771–6.
- ▶ Liu GT, Crenner CW, Logigian EL, Charness ME, Samuels MA. Midbrain syndromes of Benedikt, Claude, and Nothnagel: setting the record straight. Neurology. 1992;42(9):1820–2.
- ▶ Kim SH, Lee KC, Kim SH. Cranial nerve palsies accompanying pituitary tumour. J Clin Neurosci. 2007;14:1158–62.
- ▶ Chen Z, Murray AW, Quinlan JJ. Pituitary apoplexy presenting as unilateral third cranial nerve palsy after coronary artery bypass surgery. Anesth Analg. 2004;98(1):46–8.
- ▶ Saul RF, Hilliker JK. Third nerve palsy: the presenting sign of a pituitary adenoma in five patients and the only neurological sign in four patients. J Clin Neuroophthalmol. 1985;5(3):185–93.
- ▶ Lazaridis C, Torabi A, Cannon S. Bilateral third nerve palsy and temporal arteritis. Arch Neurol. 2005;62(11): 1766–8.
- ▶ Oncel C, Bir F, Bir LS. Simultaneous ischemic optic neuropathy and third cranial nerve palsy in giant cell arteritis. J Neuroophthalmol. 2007;27(4):315–6.
- ▶ Paik JW, Kang SY, Sohn YH. Isolated abducens nerve palsy due to anterolateral pontine infarction. Eur Neurol. 2004;52(4):254–6.
- ▶ Victor M, Adams R, Collins GH. The Wernicke-Korsakoff syndrome and related neurological disorders due to alcoholism and malnutrition. 2nd ed. Philadelphia: F. A. Davis Company; 1989.