Review of Anatomy
- Iris sphincter
- Iris dilator
- Parasympathetic pathway
- Sympathetic pathway

Parasympathetic Pathway
- Light stimulates the retina then impulse travels with the ganglion cells through the chiasm into the optic tracts. 80% go to the LGN, 20% to the pretectal nuclei. They then hemidecussate and terminate at the EW nucleus
Points of Interest

- Within the second order neuron there are 30 near response fibers for every light response fiber. This allows for light-near dissociation.
- The third order neuron runs with cranial nerve III from the brain stem to the ciliary ganglion. Superficially located prior to the cavernous sinus.

Sympathetic Pathway

- Three neuron arc
  - Posterior hypothalamus to ciliospinal center of Budge (C8 - T2). (1)
  - Center of Budge to the superior cervical ganglion in the neck (2)
  - Superior cervical ganglion to the dilator muscle (3)

Points of Interest

- Second order neuron runs along the surface of the lung, can be affected by a Pancoast tumor
- Third order neuron runs with the carotid artery then with the ophthalmic division of cranial nerve V
Testing

- APD / reverse APD
- Direct and consensual response
- Which is the abnormal pupil?
- Very simple rule. Compare in light and dark.
- Is accommodation affected?
- No circumstance where light response is present but near is absent

Question

- What happens if one shines a bright light directly (without shining it in the other eye first) into an eye with an APD?

Normal swinging flashlight test

Left APD

Question

- What is a reverse APD?
- Can patients with a hemianopsia (matching in both eyes) have an APD?
Hemianopsia and APD

- YES!
- Hallmark of optic tract lesions
- APD in the eye with temporal VF loss
- Due to higher percentage of crossed (nasal) than uncrossed (temporal) fibers

Causes of Pupil Abnormalities

- Physiological anisocoria. Up to 25% of the population. May switch sides and may be transient. Unequal supranuclear inhibition in EW nucleus. Fairly consistent across light levels
- Structural abnormalities and sphincter tears
- Age / ischemia
- Pharmacological agents
- Benign Episodic Pupillary Mydriasis (women who suffer migraines: lasts minutes to one week but usually about 12 hours. May or may not react to light)

Pharmacology

- Topical drugs (Visine)
- Systemic drugs. Heroin, morphine, codeine lead to miosis. Dramamine, cocaine, levodopa, and antihistamines lead to mydriasis. Belladona and Jimson
- Angel's Trumpet (Datura)
- Preparation H!!!!!!! (2.5% phenyl)
- Scopolomine motion sickness patches
- Flea / tick control products
- 1% pilocarpine test. Will constrict a compressive or tonic pupil but not a pharmacological one (except maybe Visine)

Angel's Trumpet

Pharmacology

- Flea and tick sprays / collars / powders
- Some cause mydriasis, some cause miosis!

Permethrin

- Also found in agricultural pesticides and “cow rubs”
- In a scabies treatment: Lyclear, a 5% cream
- Highly toxic to fish and cats (dog collars can kill)
Pathology / Syndromes
- Argyll - Robertson
- Adie's Tonic
- Midbrain lesions
- Horner's
- Third nerve palsy

Argyll - Robertson
- Bilateral, asymmetrically miotic pupils which are irregular
- Poor dilation with poor response to light but brisk near response
- Hallmark of tertiary neurosyphilis.

Argyll-Robertson pupil

Adie's Tonic (Holmes-Adie)
- Affected pupil larger originally but becomes smaller with time. Originally unilateral but may become bilateral
- Benign lesion of ciliary ganglion resulting in neuronal loss and aberrant regeneration. Affects mostly women in their 20's and 30's
- Often decreased deep tendon reflexes (achilles most common)
- Tendon reflex loss originally on same side as pupil problem-later bilateral. ? Viral etiology

Adie's Tonic
- Light reaction poor or absent while accommodation is slow and tonic. Can mimic A-R when bilateral and longstanding
- Poor re-dilation after accommodation and vermiform movements are common
- Light / near dissociation possible after some regeneration has occurred (8 weeks)
- Test with 1/8 % pilocarpine. Will constrict while normal pupil will not (studies show that pilocarpine must be diluted to .0625% before there is absolutely no constriction of normal)

Adie's tonic pupil (OD)
Adie’s tonic pupil

Midbrain Lesion
- Affected pupils are larger, often light/near dissociation like A-R pupils. Vertical gaze restrictions, convergence nystagmus on attempted upgaze
- Parinaud’s syndrome / Dorsal midbrain syndrome
- Can be caused by a pinealoma, stroke, MS, infection lesion, metastatic lesion, etc.
- Papilledema frequently with pinealoma

Horner’s
- Miosis with normal reaction to light
- Ptosis and upside down ptosis (loss of muscle tone)
- Heterochromia if congenital and anhydrosis if the lesion is below the SC ganglion but before the carotid bifurcation
- Hypotony
- Can occasionally get partial involvement with ptosis only (no miosis)

Horner’s Causes
- First order: Neoplasms, Wallenberg’s syndrome, trauma, vertebral-basilar insufficiency
- Second order: Pancoast or thyroid tumor, neck trauma or surgery
- Third order: Cluster headaches, cavernous sinus lesion, dissecting carotid aneurysm
- Testing: MRI, MRA, and chest X-ray

Horner’s
- Testing: 4% cocaine will dilate a normal pupil by blocking the re-uptake of epinephrine but will not dilate the Horner’s pupil. Shelf life of only six months if preserved and cost of $90
- More practical: 1% Iopidine will dilate a Horner’s pupil after 30-45 minutes but will not dilate a normal pupil. 0.5% works also. May not work until at least 2 weeks out
- 1% hydroxyamphetamine will dilate a first or second order Horner’s but not a third by releasing NE from postganglionic synapses. Must wait one hour to check and need 72 hour washout if cocaine was used
- Ptosis only patients will get lid elevation with Naphazoline. Little pupillary mydriasis.

Apraclonidine side effects
- In infants under six months of age......
- Severe lethargy with bradycardia and decreased respiration
- Several cases reported where hospitalization with oxygen was required
Wallenberg’s syndrome

- Stroke of vertebral or posterior inferior cerebellar artery in the brainstem
- Difficulty swallowing
- Hoarseness
- Dizziness
- Nausea
- Gait disturbance
- Nystagmus
- Uncontrollable hiccups

Raeder’s syndrome

- Horner’s with pain in the distribution area of V1. Caused by a neoplasm compressing the trigeminal nerve. Differential for cluster headaches.

Horner’s pupil (OS)

Horner’s pupil

Horner’s pupil
Third Nerve Palsy

- Partial vs. Complete. Complete will show fixed, dilated pupil with ptosis and restricted motility. Eye will be down and out and patient will complain of diplopia.
- May actually involve only the pupil where fibers are superficial.

Pupil sparing / Pupil involving

- Rule of thumb: Pupil sparing third nerve palsies tend to be ischemic while those involving the pupil tend to be due to aneurysms or tumors.
- Not a firm rule.
- Pupil sparing may become pupil involving so follow very closely.
- May get pupil involvement only in rare cases such as basilar artery aneurysms.

Pupil involving vs. pupil sparing

- Immediate MRI if any question of aneurysmal involvement. Patient may complain of a severe headache and will often have other neurological signs.
- If patient is diabetic or hypertensive and the pupil is not involved, can consider not imaging, but 15-20% who fit this profile will have mass or aneurysm, so may be prudent to scan all.

Third Nerve Management

- Patient education and reassurance a must.
- Diplopia relief with patching.
- Most ischemic palsies resolve over several months.

Third Nerve Management
Third nerve palsy

- Right third nerve palsy

Left third nerve palsy
Summary

- Abnormally Large Pupil
  - CN III Palsy
  - Acute Adie’s tonic pupil
  - Drugs
  - Iris damage
  - B.E.P.M.

- Abnormally Small Pupil
  - Horner’s
  - Argyll-Rob.
  - Simple anisocoria
  - Drugs