Pupil Abnormalities

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Case Scenario Links

Pupil Abnormalities

• Pupil abnormality (Oph08)
• Diplopia (Oph06)
• Infant with strabismus (Oph09)
• Sudden loss of vision and headache (Oph05)
• Altered level of consciousness in an adult (N04)
Pathway of the pupillary light reflex consists of:

- Retinal receptor cells
- Bipolar cells
- Ganglion cells
- Optic nerve and tract
- Pretectal nucleus in the midbrain
- Edinger-Westphal nucleus
- Two neurone pathway via the Oculomotor nerve
- Sphincter pupillae (constrictor muscle of iris)

Afferent visual pathway

Efferent visual pathway
Anatomy of Pupil Reflexes

The size of the pupils depends on the balance of parasympathetic and sympathetic activity supplying the iris (efferent visual pathway):

- parasympathetic activity *constricts* the pupil
- sympathetic activity *dilates* the pupil
The Light Reflex
The Light Reflex

The parasympathetic pathway

Sympathetic Pathway
Sympathetic Pathway

Normal Light Reflex

Examination of Pupils

**Before dilating**

- size, symmetry
- shape
- near reflex
- light reflex
- Relative afferent pupil defect (RAPD)
Anisocoria

- Difference in pupil size between the eyes
- May be physiological or pathological
- Physiological anisocoria
  - normal variation in pupil size
  - uncommon
  - usually less than 1mm
Factors Affecting Pupil Size

- **Topical medications:**
  - Mydriatics / miotics / other agents

- **Trauma:**
  - Traumatic mydriasis / sphincter rupture / surgical trauma / posterior synechiae

- **Disease processes:**
  - Uveitis / acute angle closure glaucoma

- **Systemic medications:**
  - Narcotics (morphine, pethidine) cause miosis
Conditions with Pathological Pupil Size

**Abnormally small pupil:**
- Horner’s syndrome
- Argyll Robertson pupil
- Narcotics

**Abnormally large pupil:**
- Adie’s tonic pupil
- Pupil involved 3rd nerve palsy
- Bilateral dilated pupils - coma
Horner’s Syndrome

Oculosympathetic paresis... interruption of the sympathetic supply along the three neuron pathway

Miosis
- Ptosis
- Apparent enophthalmos
- Cutaneous anhydrosis
- Other features – iris hypopigmentation in congenital cases
Horner’s Syndrome

- Diagnosis confirmed by topical cocaine test

- Abnormal pupil fails to dilate whilst the normal pupil will dilate (loss of noradrenaline at nerve junction)

- Other associated clinical signs and symptoms: headache / apical lung pathology / long tract neurology signs will determine appropriate investigations
Right Horner’s Syndrome
Argyll Robertson Pupil

- Specific sign of neurosyphilis
- Small and irregular pupils
- Usually bilateral but asymmetric
- Do not respond to light but near response normal (light-near dissociation)
Adie’s Pupil

Postganglionic parasympathetic denervation:

• Causes: idiopathic, viral, diabetes, trauma
• Glare / accommodative difficulties

Mydriasis

• Light – near dissociation....slow constriction on prolonged near effort and slow re-dilation to distance
• Usually young females – 90% unilateral initially , but often becomes bilateral
• Pupil becomes tonic with time....even miotic
• If decreased tendon reflexes present- Holmes Adie syndrome
Adie’s Pupil

• Diagnosis confirmed by denervation hypersensitivity to weak cholinergic (pilocarpine 0.1%)… abnormal pupil will constrict whilst normal pupil remains unaffected

• Aberrant re-innervation of pupillary sphincter muscle ... contractions of part of the pupil margin (vermiform movement)
Bilateral recent Adie’s pupils

Semi-dilated, irregular; iris affected segmentally
Anatomy of the CN III

Oculomotor nucleus

Pons

Clivus

Applied Anatomy of the CN III

Vasa nervorum supply part of nerve but not pupillary fibres. Pupil sparing in medical (non-compressive) lesions e.g. diabetes

Blood vessels on pia mater supply surface of the nerve including pupillary fibres (damaged by compressive lesions)

Causes of CN III palsy

**Microvascular infarction**
- Occlusion vasa nervorum
- Risks: diabetes, hypertension, atherosclerosis

**Compressive lesion**
- Aneurysm (usually post communicating artery)
- Tumour

**Trauma**
CN III Palsy

- Ptosis, mydriasis and cycloplegia
- Eye down and out
- Normal abduction
- Limited depression
- Limited elevation
- Limited adduction
Partial right CN III Palsy
Left CN III palsy
What do you look for if there is anisocoria?

• Make sure patient has not had any eye drops instilled
• Check for prescription, over the counter vasoconstrictors or ‘herbal’ medications
• Any history of eye surgery (iatrogenic)
• Check for other signs such as ptosis, or ocular motility problems
Relative Afferent Pupil Defect (RAPD)

• The presence of RAPD in the absence of gross ocular disease indicates a neurological lesion of the anterior visual pathway (afferent system).

• Detected using the ‘swinging flashlight test’

• Abnormal pupil responds to consensual light but not direct light
Causes of RAPD

- **Optic nerve disorders** (optic nerve compression, optic neuritis)
- Chiasma compression
- Retinal detachment
- Large unilateral macular lesion
- Unilateral glaucoma

- RAPD **not produced by** corneal opacity, cataract, vitreous haemorrhage, refractive error, amblyopia.
Relative Afferent Pupil Defect

Relative Afferent Pupil Defect

RAPD video
Available for viewing on UOA Ophthalmology website
Mydriatics

- Cholinergic antagonists (anticholinergics)
  - Atropine
  - Cyclopentolate (Cyclogyl)
  - Tropicamide (Mydriacyl)

Systemic effects: Atropine: “Hot as a hare, mad as a hatter, red as a beet”
Mydriatics continued

- **Adrenergic agents**
  - adrenergic agonist- phenylephrine 2.5% and 10%

  Systemic effects: Hypertension, stroke, myocardial infarct

  $\alpha_1$ receptors mediate smooth muscle contraction

  Cocaine blocks reuptake of noradrenalin into presynaptic vesicles, thus accumulating and causing dilatation in an intact neuron
Miotics

- **Cholinergic (direct):** Pilocarpine
- **Anticholinesterases (indirect cholinergic):** physostigmine, neostigmine

Postganglionic parasympathetic nerves respond to muscarine.
Somatic motor and preganglionic autonomic nerves respond to nicotine
The End

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