OCULAR MANIFESTATIONS OF NEUROLOGICAL EVENTS

Dr Rahul Chakrabarti, FRANZCO

Consultant General Ophthalmologist

29th November, 2021, Early Career Optometry Webinar

The Royal Victorian Eye and Ear Hospital

Private Rooms: Essendon Eye Clinic, Northwest Eye Specialists, East Melbourne Eye Group, Mildura Eye Specialists

Senior Lecturer (Ophthalmology), The University of Melbourne

Adjunct Senior Lecturer (Ophthalmology), Monash University

rahul.chakrabarti@eyeandear.org.au

TOPICS

- Traumatic optic neuropathy
- Ocular manifestations in patients with cerebrovascular accidents
  - Cortical stroke: Vertical gaze palsy
  - Subcortical stroke: Horizontal gaze palsy, Parinauds, INO
  - Nystagmus
  - Convergence insufficiency
- Ocular manifestations of acquired head injury
  - Pupillary involvement: Horner syndrome
  - Optic nerve trauma
  - Lateral rectus palsy
  - Concussion

OCULAR MANIFESTATIONS IN PATIENTS WITH STROKE

- Mean age 51 years
- 90% of stroke survivors experience ophthalmic issues (**need early eye examination)**
- Sub-cortical stroke (60%), cortical stroke (40%)
- **Visual defects – 40%** (Patients reporting vision impairment 30%)
- **Gaze palsy – 40%**
  - *Vertical gaze palsy* (30%) – more common in cortical stroke
  - *Horizontal gaze palsy* (25%) – more common in sub-cortical stroke
  - *Internuclear ophthalmoplegia* (10%)
  - *Parinaud syndrome*
- **Nystagmus – 50%**
- **Convergence insufficiency – 40%**
- Diplopia – 10%
- **Retinal abnormalities in 60%:** Hypertensive, diabetic, emboli, CRAO

Dadia et. al (2019) Int Ophthalmol, 39:2843-49

OCULAR MANIFESTATIONS OF HEAD INJURY

- Head injuries are common – > 50% of all trauma deaths
- Many ophthalmic manifestations are ignored – late referral
- Causes: Traffic accident (50%), assault (35%), Occupational (7%), other (8%)
- Ophthalmic manifestations – can affect any part of the eye / adenexae
  - Intraocular 20%
  - Extra ocular 50%
  - Orbital fracture 10%
- **Patients with eye signs of neurological significance – increased risk of death**

Kulkarni et al. 2005. Eye. 19:1257-1263

NEUROLOGICAL SIGNIFICANCE

- Pupil abnormalities 7%
- Papilloedema 6%
- Lateral rectus palsy 2%
- Ptosis – neurogenic 1.5%
- Traumatic optic neuropathy 0.5%

EXTRA-OCULAR MANIFESTATIONS

- **Ecchymosis 27%**
- Lateral rectus palsy 2%
- Lacrimal gland prolapse
- **Subconjunctival haemorrhage 20%**
- Ptosis
- **Proptosis 3%**
- **Orbital wall fractures 12%**
  - Orbital margin (10%)
  - Blow out

INTRA-OCULAR MANIFESTATIONS

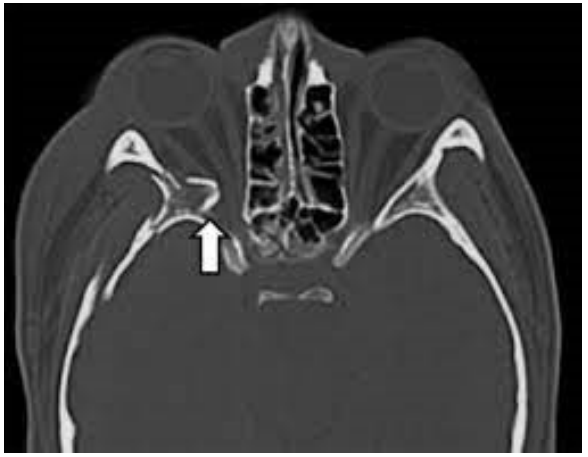
- Optic nerve trauma 0.5%
- **Pupil involvement 7%**
- **Papilloedema 5%**
- **Macular oedema 2%**
- Vitreous haemorrhage
- Retinal haemorrhage
- Corneal abrasion/ lamellar laceration
- Scleral laceration
- Hyphaema

TRAUMATIC OPTIC NEUROPATHY

- Ocular, orbital or head trauma → sudden vision loss (not explained by other pathology – 5% of facial fractures
- **Classification**
  - **Direct:** blunt/ sharp (e.g bony fragments) → damages optic nerve
  - **Indirect:** force transmitted (more common)
- **Mechanisms**
  - Contusion, deformation, compression, transection, shearing, vasospasm, oedema
- **Presentation**
  - Visual acuity – Poor from onset (Perception of light only -50%)
  - RAPD
  - Optic nerve head – initially may be NORMAL → Pallor later
- **Investigations**
  - CT Orbits – more effective in bony abnormalities (e.g. optic canal fracture)
  - MRI – soft tissue changes, e.g. haematoma

TRAUMATIC OPTIC NEUROPATHY

- **Treatment**
  - If orbital compartment syndrome → urgent lateral canthotomy + cantholysis
  - Spontaneous improvement – 50% of patients with indirect mechanism
  - Poor prognosis if < PL initially
  - Other treatments – **no clear evidence**
    - *Steroids* – Intravenous methylprednisolone – start < 8 hours
      - **CRASH Study → IVMP in acute brain injury patients → increased death!**
    - *Optic nerve decompression*
      - Ongoing vision loss, bilateral vision loss
      - Address if bony fragment
      - If optic canal fracture → poor prognosis
    - *Optic nerve sheath fenestration* – little evidence



HORNER'S SYNDROME

- **Oculosympathetic palsy**
- **Anatomy Revision**
  - Sympathetic supply 3 orders of neurons
  - 1st (Central): **Hypothalamus,** uncrossed → **ciliospinal centre of Budge** (between C8-T2)
  - 2nd (Pre-ganglionic): Centre of Budge → **Superior cervical ganglion** (neck) – closed to apex of lungs (Pancoast tumour)
  - 3rd (Post-ganglionic): Along **internal carotid a** .→ cavernous sinus → **ophthalmic division of trigeminal nerve** (5th cranial n) → ciliary body → **nasociliary + long ciliary n.** → dilator pupillae

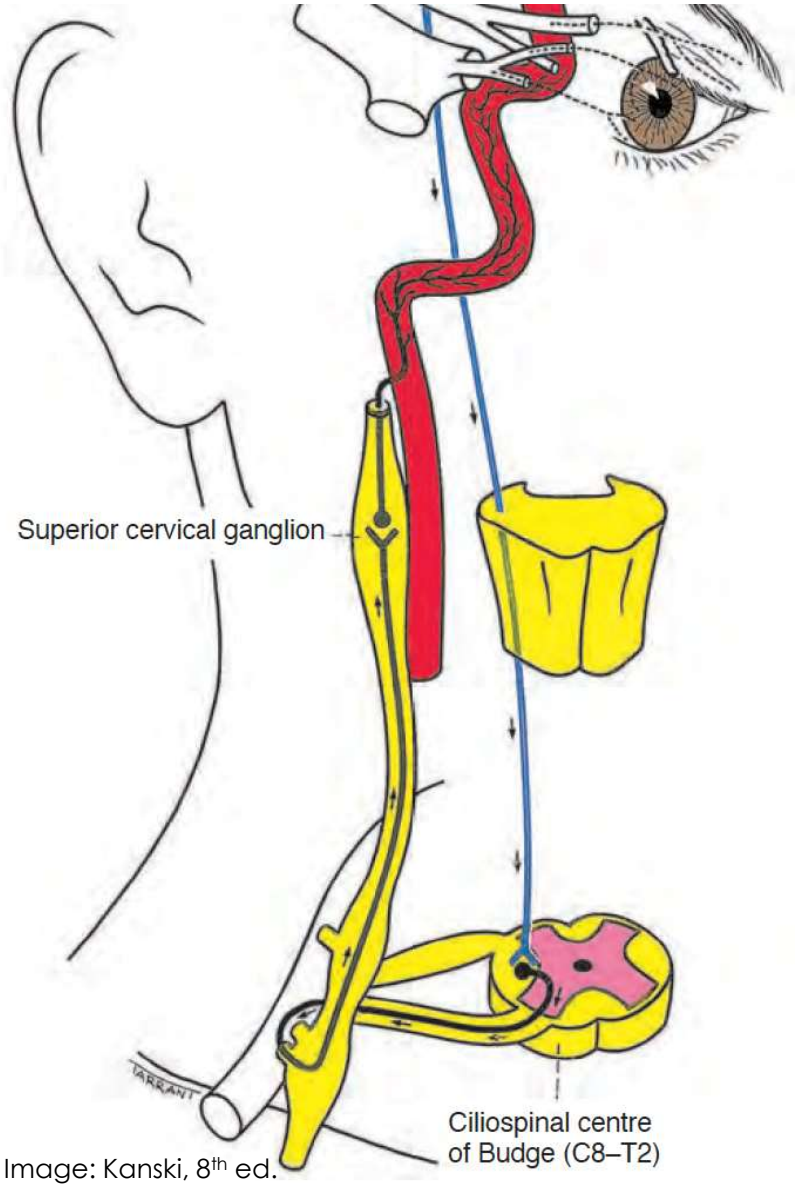


Image: Kanski, 8th ed.

HORNER SYNDROME CAUSES

- 1st Order: **Brainstem disease**, lateral medullary syndrome, **cervical cord,** Diabetic autonomic neuropathy
- 2nd Order: Pancoast tumour, **Carotid artery (aneurysm, dissection),** neck lesions, **thoracic spine lesions**
- 3rd Order **ICA dissection**, nasopharyngeal tumour, cavernous sinus
- Cluster headache Migrainous neuralgia
- **Painful Horner – think carotid dissection!**

EXAMINATION

- Most unilateral (Bilateral: Diabetes, cervical spine injury)
- Mild ptosis (2mm): weak Muller muscle (upper lid retractor)
- Elevation of lower lid: weak inferior tarsal muscle
- **Anisocoria – worse in dim light**
- Dilatation lag – dilates slowly
- Pupil constriction – normal
- Iris heterochromia (congenital Horner, affected side lighter)
- Anhydrosis: ipsilateral, (only if lesion is below the superior cervical ganglion)

HORNER: PHARMACOLOGICAL TESTING

Apraclonidine, Cocaine – confirm the diagnosis

Hydroxyamphetamine – localizes the pathology

- **Apraclonidine 0.5%**: 1 drop both eyes, wait 30 minutes (do not used in infants)
  - Horner pupil → **dilates!** (normal pupil unaffected), 90% sensitive
  - **Reverses anisocoria**
  - Why? Alpha 1 receptor upregulated in denervated dilator pupillae
- **Cocaine 4%**:
  - Horner pupil → **DOES NOT Dilate** (normal pupil will dilate)
  - Why? Cocaine blocks Noradrenaline reuptake at post-ganglionic end → dilates normal pupil
  - Horner: No Noradrenaline being released → no dilation
- **Phenylephrine 1%**
  - Horner pupil → **dilates** + **ptosis may improve**
  - Post-ganglionic lesions only
  - Why? Post-ganglionic Horner – denerveation hypersensitivity
- **Hydroxyamphetamine** (differentiates pre-ganglionic: 1st/ 2nd order vs post-ganglionic: 3rd order)
  - Post-ganglionic Horner → **DOES NOT Dilate (**Normal, pre-ganglionic will dilate)
  - Why? Amphetamine releases Noradrenaline from normal post-ganglionic endings.

HORNER: MANAGEMENT

- **Investigation**
  - **CT / MR Angiography**: Aortic arch → Circle of Willis
  - Exclude neck, thyroid, lung apices, skull base lesions
  - MR more useful – brainstem lesions
- **Treatment**
  - Treat cause
  - Apraclonidine – temporary

OCULAR MANIFESTATIONS IN PATIENTS WITH CEREBROVASCULAR ACCIDENTS

- Cerebrovascular accident (CVA): one of the most common causes of adult mortality and disability
- 3 types of CVA
  - Ischaemic (most common)
  - Haemorrhagic
  - Transient
- Neuro-ophthalmic manifestations
  - Gaze palsies, gaze preferences, Strabismus, Visual field defects, Cortical blindness, Nystagmus, Ptosis, Diplopia
- Document, Localise lesion

SUPRANUCLEAR DISORDERS OF OCULAR MOTILITY

- Conjugate eye movements
- Abnormalities of horizontal gaze
- Vertical gaze palsy
- Skew Deviation

CONJUGATE EYE MOVEMENTS

- 3 Main types
  - **Saccades:** Frontal eye field (pre-motor cortex) → *contra-lateral* Paramedian pontine reticular formation (PPRF) – horizontal
  - **Pursuits** Multiple cortex regions, PPRF, superior colliculi, cerebellum → *Ipsilateral* → Pursuit to the *same* side
  - **Non-optic reflex movements** Vestibular → horizontal gaze centre
- Disturbance of supra-nuclear eye movement → gaze palsy

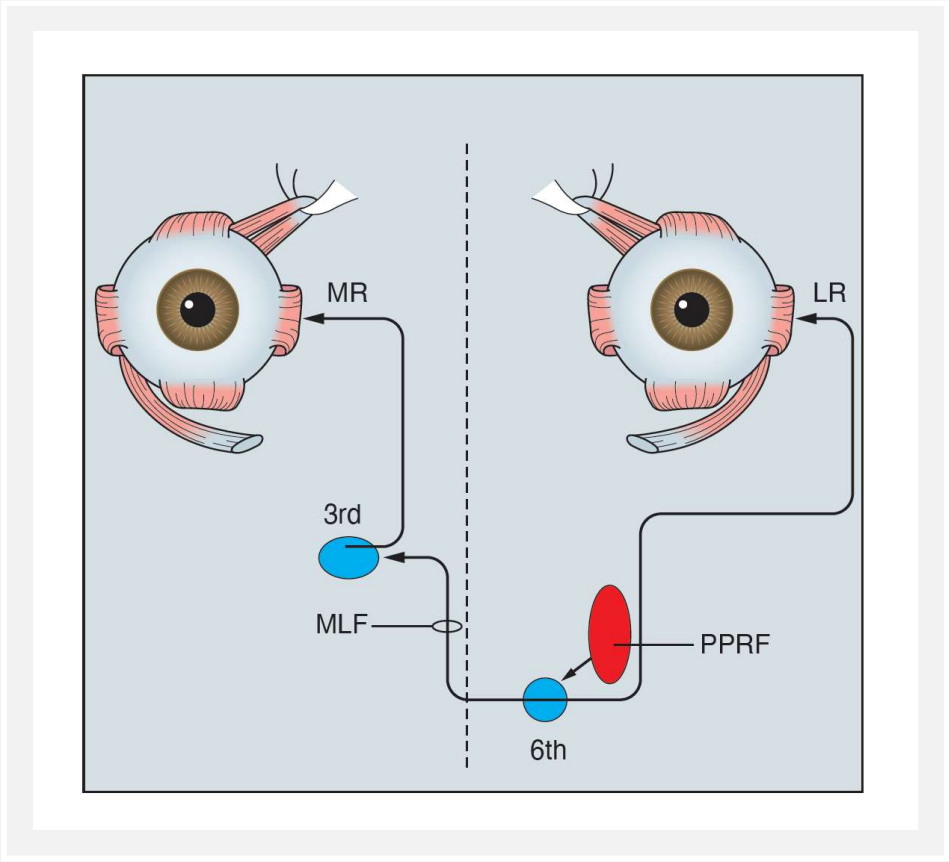


Image: Kanski, 8th ed.

ABNORMALITIES OF HORIZONTAL GAZE

- Anatomy
  - Initiated by horizontal gaze centre **(Paramedian pontine reticular formation) PPRF**
  - **Direct** → *Ipsilateral* 6th nerve nucleus (Abducens)
  - **Indirect** → Medial longitudinal fasciculus → *Contralateral* 3rd nerve (Oculomotor)
  - Allows conjugate movement of eyes to the same side

HORIZONTAL GAZE PALSY

- Lesion of horizontal gaze centre (PPRF)
- Examination
  - Ipsilateral horizontal gaze palsy
  - Inability to look in direction of the lesion
  - E.g. left horizontal gaze palsy = Lesion of Left PPRF

INTERNUCLEAR OPHTHALMOPLEGIA

- Lesion of the Medial Longitudinal Fasciculus (MLF)
- Causes: Demyelination, stroke, tumours
- **Unilateral INO**
  - Eyes straight in primary
  - Limited ADDUCTION on side of lesion
  - Horizontal nystagmus *contralateral* eye on ABDUCTION
- **Bilateral INO**
  - Limited Right adduction and left eye abducting nystagmus
  - Limited Left adduction and Right abducting nystagmus
  - Convergence – may be *in tact or abnormal*
  - **Wall-Eyed Bilateral INO (WEBINO)** Lesion: Rostral midbrain = Bilateral INO + abnormal convergence + exotropia
- **One + Half Syndrome**
  - Lesion of PPRF + MLF = Ipsilateral gaze Palsy + INO
  - That is – only movement possible is *abduction of contralateral eye with abducting nystagmus*
- Treatment: Strabismus surgery is possible for persistent diplopia

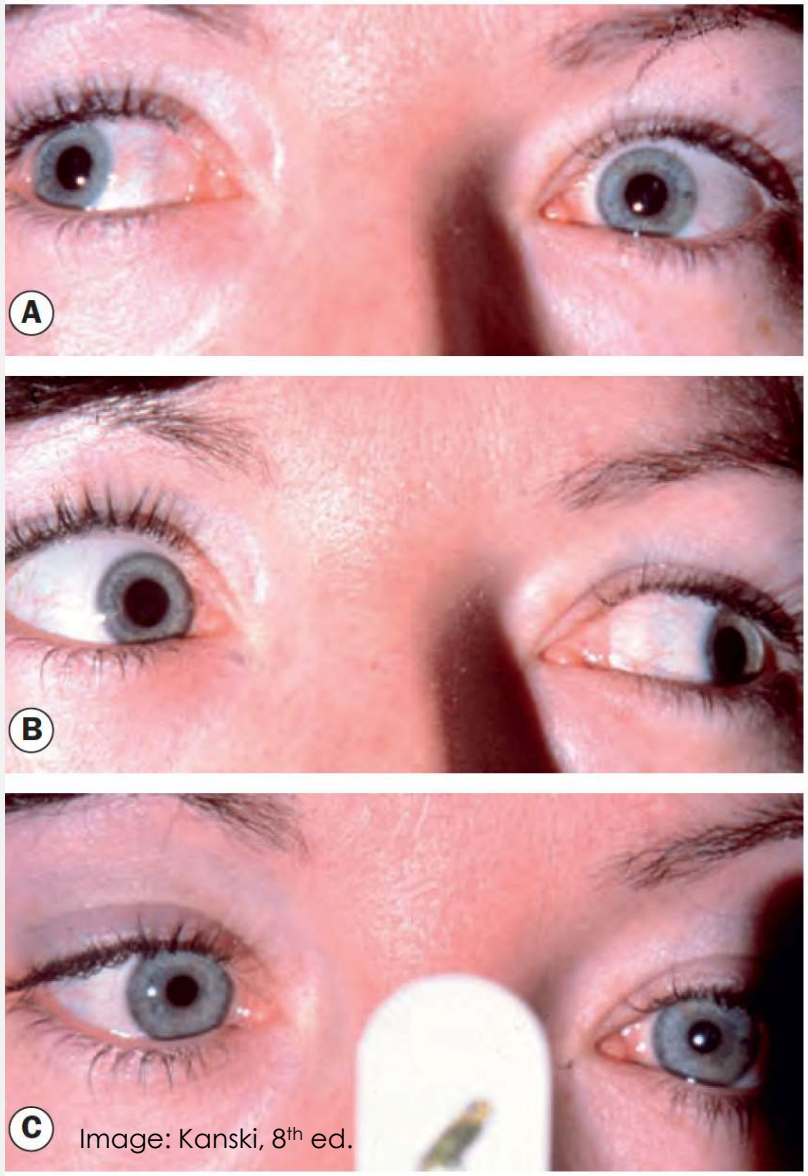


Image: Kanski, 8th ed.

VERTICAL GAZE PALSY

- Anatomy
  - Initiated in **frontal lobes**
  - Bilateral impulses → vertical gaze centre in midbrain in the **Ri-MLF** (Rostral interstitial nucleus of the medial longitudinal fasciculus)
  - Impulses **pass to subnuclei of eye muscles** controlling vertical gaze in both eyes

PARINAUD SYNDROME

- Dorsal midbrain syndrome
- Signs (UCLA)
  - Supranuclear **upgaze** palsy
  - **Convergence** deficiency
  - **Convergence-retraction nystagmus**
  - **Lid retraction** (Collier's sign)
  - Asymmetry of pupils: **Light-near dissociation** (Accommodation preserved, do not react)
- Causes
  - Children: cerebral aqueduct stenosis, meningitis, pinealoma
  - Young adults: demyelination, trauma, AV malformation
  - Elderly: Midbrain strokes, mass lesions, posterior fossa aneurysms

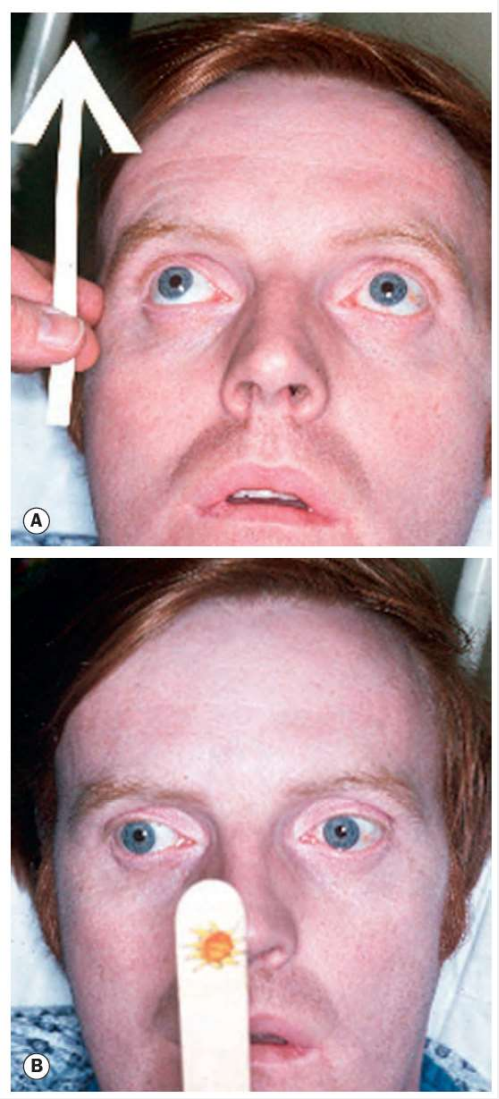


Image: Kanski, 8th ed.

SKEW DEVIATION

- Uncommon
- Clinical signs
  - Vertical deviation
  - Excyclotorsion
- 3 categories
  - Both eyes deviated upwards
  - One eye hypertropia
  - One eye hypotropia
- Causes
  - Brainstem or Cerebellar stroke

PROGRESSIVE SUPRANUCLEAR PALSY

- Degenerative, old age
- Clinical features
  - Supranuclear gaze palsy: initially downgaze → upgaze → horizontal→ global limitation
  - Convergence impaired
  - Pseudobulbar palsy
  - Extrapyramidal signs: rigidity, gait ataxia, dementia

ABDUCENS PALSY: ANATOMY + FUNCTION

- **Anatomy**
  - 6th nerve (abducens) nucleus: pons (base of 4th ventricle)
  - **Brainstem lesion**:
    - Nuclear → failure of horizontal gaze (gaze palsy to side of lesion)
    - Foville (inferior medial pons) → Cranial n 5-8, Central Horner syndrome, + horizontal gaze palsy
    - Ventral pons (Millard Gublar) → Ipsilateral 6th n + contralateral hemiplegia
  - **Basilar lesion (as it enters base of skull)**
    - Hearing loss, reduced corneal sensaion (why? – pontomedullary junction, acoustic neuroma)
    - **Check corneal sensation and hearing in all patients with 6th nerve palsy**
    - **Raised intra-cranial pressure:** due to stretching of one / both 6th nerves as they pass over the petrous tip (false localizing sign)
    - Gradenigo syndrome: mastoiditis → 6th nerve + facial weakness, pain + hearing loss
  - **Intracavernous / orbital lesion**

6TH NERVE PALSY: DIAGNOSIS

- Symptoms
  - Diplopia, horizontal, worse at distance (less/ absent at near)
- Signs
  - Esotropia
  - Limited abduction of affected eye
  - Bilateral 6th nerve: **must exclude raised intra-cranial pressure**
  - Compensatory face turn – towards side of lesion
  - Examine all cranial nerves
- When to investigate?
  - **Younger patients, middle age, painful, multiple cranial nerves, bilateral 6th – NEED URGENT SCANNING**
  - Microvascular (up to 60% of older patients), Unlike 4th nerve - "decompensated" is rare

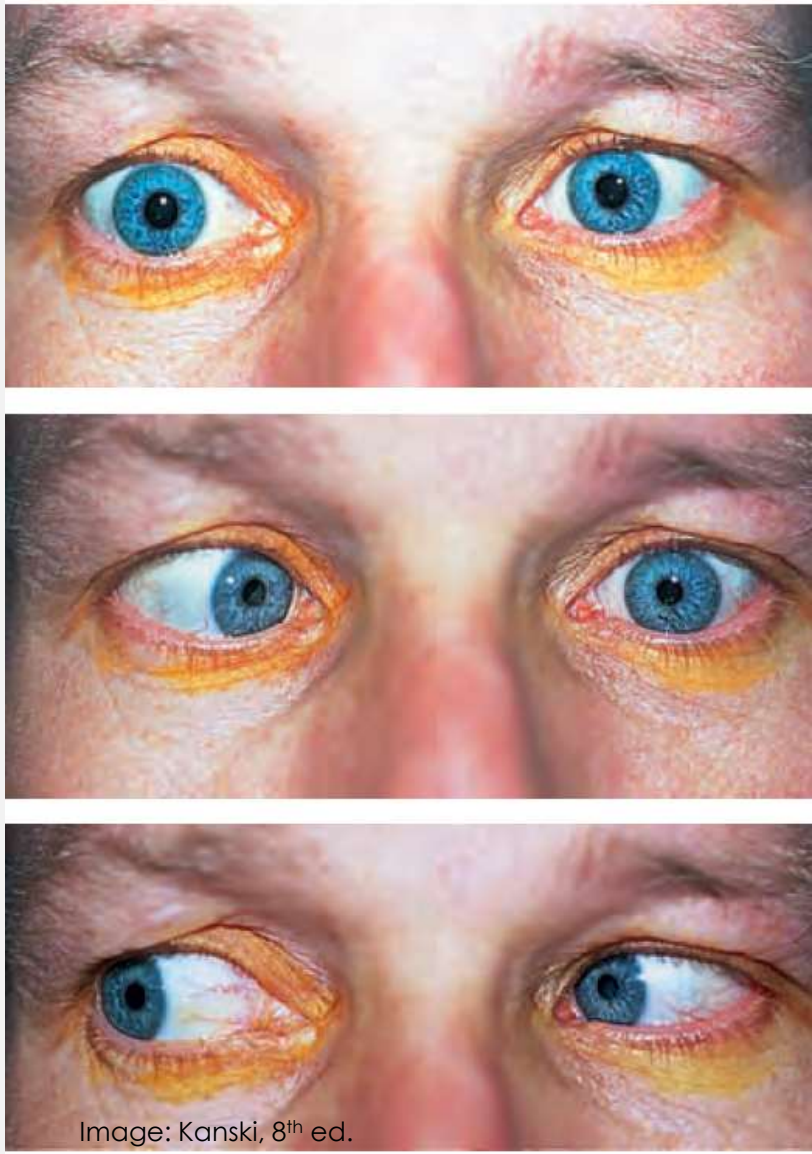


Image: Kanski, 8th ed.

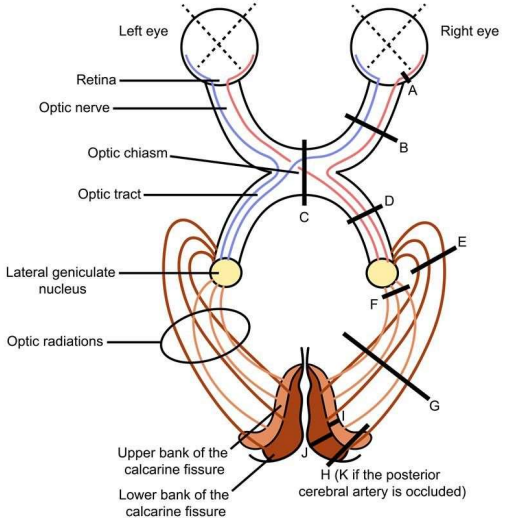
6TH NERVE PALSY: TREATMENT

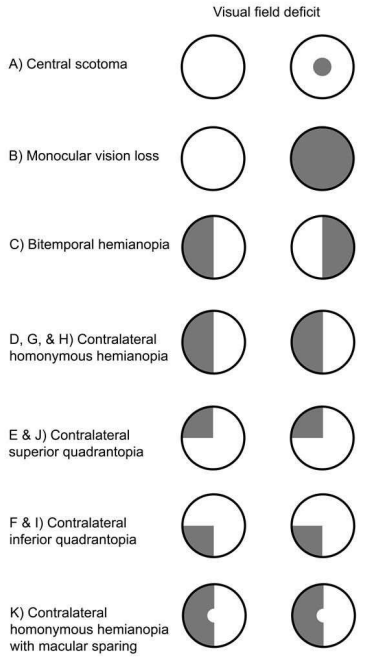
- Typically avoid surgery for at least 6 months (usually 12 months)
- 90% resolve by 6 months
- Observe: Monocular occlusion or Fresnel base OUT
- Permanent prism can be an option to surgery
- Botulinum toxin: to ipsilateral medial rectus (prevents contracture), rarely curative
- Strabismus surgery:
  - Partial: adjustable medial rectus recess in affected eye
  - Complete: transposition of superior and inferior recti → lateral rectus +- Botox to medial rectus

VISUAL FIELD DEFICITS IN STROKE SYNDROMES

- Clinical assessment: Neglect, Confrontation
  - Neglect: ask patient to mark midpoint of a horizontal line on a sheet of paper
- Static perimetry: Humphrey Field Analyser, 30-2 preferred
- Common field loss patterns
  - **Homonymous hemianopia** **33**% (more in cortical stroke)
  - Heteronymous heminopia (Incongruous) 4% (more in sub-cortical stroke)
  - Quadranatopia 10% (more in cortical stroke)
  - Constricted 12% (similar cortical = sub-cortical stroke)
  - **Altitudinal defects** **20%** (similar cortical = sub-cortical stroke)
  - **Hemineglect** **21%** (more in cortical stroke)

Visual Field Defects





Moises Dominguez

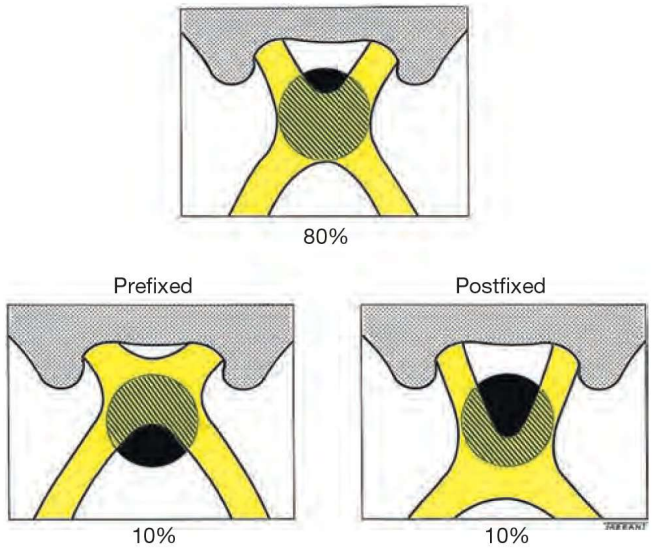
Talley and O'Connor, 9th ed.

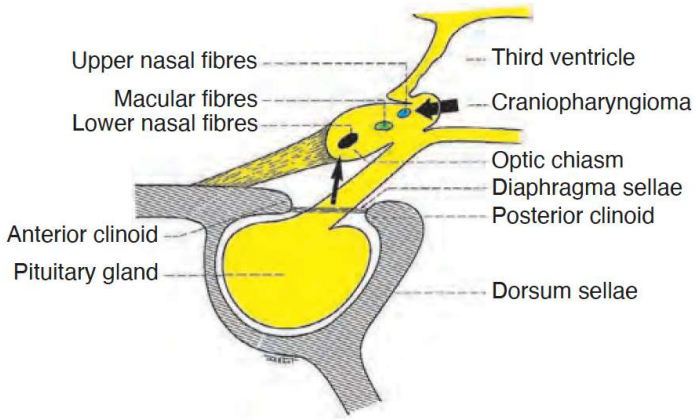
OPTIC TRACT PATHOLOGY

- **Homonymous hemianopia**
  - Incongruous: how much it matches field of other eye
  - Hemianopia in anterior retrochiasmal pathology typically is **incongruous**
- **Wernicke's hemianopic pupil**
  - Optic tracts contain both pupillomotor and visual fibres
  - Pupil fibres leave optic tract anterior to the LGN
  - Hence possible for RAPD (absent when involved hemi-retina is tested)
- **Optic atrophy**
- **Contralateral pyramidal signs (**spasticity, weakness, slow alternate movements, hyper-reflexia, upward plantar reflex)

OPTIC RADIATION PATHOLOGY

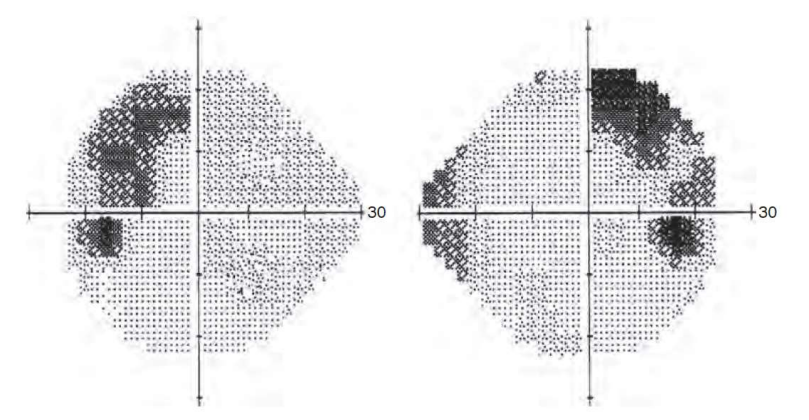
- Anatomy: LGN → striate cortex
- **P**arietal **I**nferior **T**emporal **S**uperior
- **Temporal radiations**
  - Contain inferior fibres of optic radiations (superior visual fields)
  - Visual field deficit = Contralateral superior homonymous quadranatopia
  - Other: hemisensory deficits, hemiparesis (arms and legs), hallucinations, seizures
- **Parietal radiations**
  - Contain superior fibres of optic radiations (inferior visual fields)
  - Visual field deficit = Contralateral inferior homonymous quadranatopia
  - Other:
    - Dominant parietal lobe (acalulia, agraphia, left-right disorientation)
    - Non dominant parietal lobe (dressing agnosia, spatial neglect)





OPTIC CHIASM ANATOMY

Image: Kanski, 8th ed.



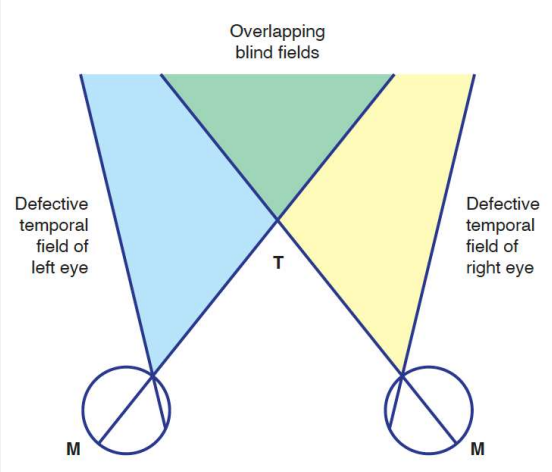


Image: Kanski, 8th ed.

CHIASMAL DEFICITS: STRUCTURE AND FUNCTION

Classic = Bitemporal field loss

Lower nasal optic nerve fibres traverse anterior + inferior in the chiasm → **Upper temporal field loss**

Upper nasal optic fibres traverse posterior and superiorly in the chiasm → **lower temporal field loss**

Post-fixed chiasm + Lesion in the anterior chiasm → Junctional Scotoma = Central scotoma on side of optic nerve + Contralateral superotemporal

Macular fibres: concentrated posteriorly in the chiasm (so, if pre-fixed chiasm: bitemporal PLUS central / paracentral field changes)

Other features of chiasmal lesions

- **Post-fixation blindness**: non-seeing area distal to fixation point
- **Hemifield slide:** disruption of fusion
- **See saw nystagmus**
- **Extraocular muscle paresis:** if similar pathology affects cavernous sinuses

ACQUIRED NYSTAGMUS

- Nystagmus: Involuntary oscillation, physiological (e.g OKN) or pathologic
- Pathologic: initiated by involuntary de-foveation → re-fixating saccade
- Descriptors**: DWARFF**
  - **Direction:** H / V / Rotatory / oblique / circular
  - **Waveform**: Pendular (equal velocity each direction) / Jerk (Fast phase gives direction, slow phase is actually the pathologic component)
  - **Amplitude:** Small/ Large
  - **Rest:** (is there a null?) Primary position/ gaze evoked
  - **Frequency:** Fast/ slow
  - **Family history**: especially infantile nystagmus syndrome
- Acquired types
  - Latent, Periodic alternating (PAN), Convergence-retraction, Downbeat, Upbeat, See-saw, Ataxic, Bruns

LATENT NYSTAGMUS

- Associated with infantile esotropia and dissociated vertical deviation (DVD)
- Both eyes open – no nystagmus
- Horizontal nystagmus – apparent on one eye monocular occlusion
- Fast phase in direction of fixating eye
- Manifest-latent nystagmus
  - Latency superimposed on manifest nystagmus
  - Monocular occlusion – increases amplitude of nystagmus

PERIODIC ALTERNATING NYSTAGMUS (PAN)

- Conjugate, horizontal, jerk nystagmus
- Periodically reverses direction
- Amplitude and frequency first increase → then decreases → eyes steady (low intensity, pendular) → starts reversing in opposite direction
- Whole cycle 1-3 minutes (*can be aperiodic PAN = changing cycle duration)
- Causes
  - Congenital
  - Cerebellar
  - Ataxia telangiectasia
  - Drugs - phenytoin

CONVERGENCE-RETRACTION NYSTAGMUS

- Jerk nystagmus due to co-contraction of extra-ocular muscles
- Usually medial recti
- How to elicit
  - OKN drum: rotate downwards → stimulates upward saccade → brings two eyes together (convergence movement)
- Signs
  - Globe retraction (globe retracts into orbit)
  - Parinaud syndrome features (UCLA)

DOWNBEAT NYSTAGMUS

- Vertical nystagmus, Fast phase beats down
- Elicit by lateral + down gaze
- Lesions
  - Foramen Magnum (Arnold-Chiari Malformation), syringobulbia
  - Drugs: lithium, phenytoin
  - Wernicke Encephalopathy
  - Demyelination
  - Hydrocephalus

UPBEAT NYSTAGMUS

- Vertical nystagmus, fast phase beats up
- All positions
- Causes
  - Posterior fossa lesions
  - Drugs
  - Wernicke Encephalopathy

SEE-SAW NYSTAGMUS

- Pendular nystagmus
- One eye intors, other eye depresses + extorts
- Causes
  - Parasellar tumours (Look for bitemporal hemianopia)
  - Brainstem stroke
  - Syringobulbia

ATAXIC NYSTAGMUS

- Horizontal jerk nystagmus
- Occurs in the abducting eye of patient with INO

BRUNS NYSTAGMUS

- Horizontal jerk nystagmus – coarse, in one eye
- Fine high frequency vestibular nystagmus in other eye
- Causes
  - Cerebelloponting angle tumour – e.g. Acoustic neuroma

TREATMENT OF NYSTAGMUS

- **Correct refractive error**
- **Treat amblyopia**
- **Medications:**
  - Gabapentin, Baclofen – may be helpful
- **Surgery**
  - For nystagmus which has a null point (Anderson-Kestenbaum procedure)
  - Aim: move muscles to mimi muscle tension when eyes are straight
  - Useful in abnormal head posture
  - Some patients – recession of horizontal recti (or tenectomy, Del-Osso procedure) can reduce amplitude of nystagmus – without affecting null point

CONVERGENCE INSUFFICIENCY

- **Signs**
  - Reduced near point of convergence
  - Independent of any heterophoria
  - Usually students with high near visual demands
- **Treatment**
  - Orthoptic convergence exercises (supervised better than home-based, Convergence Insufficiency Treatment Trial)
    - Aims to normalize near point, maximise fusional amplitude
  - Base-in prisms
- **Accommodative insufficiency**
  - May accompany CI
  - Causes: post-viral, idiopathi
  - School-aged children
  - Treatment: Give minimum reading correction to give clear vision

KEY TAKE HOME POINTS

- **90% of stroke survivors experience ophthalmic issues (need early eye examination)**
- **Patients with eye signs of neurological significance – increased risk of death**
- **Horner syndrome: Anisocoria – worse in dim light**
- **Painful Horner – think carotid dissection!**
- **Limited role for steroids in traumatic optic neuropathy – especially if head injury**
- **Check corneal sensation and hearing in all patients with 6th nerve palsy**
- **6th nerve palsy can be a false localizing signs - Raised intra-cranial pressure**
- **Beware of incongruous and non-classical visual fields in any stroke syndrome**

REFERENCES

- Kulkarni AR, Aggarwal SP, Kulkarni RR, Deshpande MD, Walimbe PB, Labhsetwar AS. Ocular manifestations of head injury: a clinical study. Eye (Lond). 2005 Dec;19(12):1257-63. doi: 10.1038/sj.eye.6701753. PMID: 15543173.
- Dadia S, Shinde C, Desai R, Mahajan AG, Sharma S, Singh B, Bharti S. Ocular manifestations in patients with cerebrovascular accidents in India: a cross-sectional observational study. Int Ophthalmol. 2019 Dec;39(12):2843-2849. doi: 10.1007/s10792-019-01131-7. Epub 2019 May 25. PMID: 31129750.