

Approaching Diplopia

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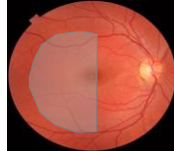
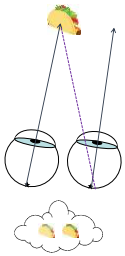
Financial Disclosure Statement:
Nothing to disclose



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Binocular Diplopia

Misalignment of the visual axis causes images to land on non-corresponding retinal points

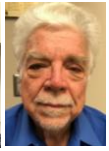
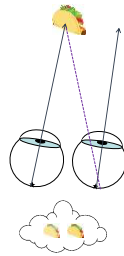


Early onset strabismus typically develop suppression or anomalous correspondence (sensory adaptations) and rarely report diplopia

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Binocular Diplopia

Misalignment of the visual axis causes images to land on non-corresponding retinal points



Late onset strabismus are less likely to have adaptations and are more likely to report diplopia

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Course Objectives

- Be familiar with differential diagnoses for diplopia
- Recognize diplopia requiring imaging and further co-management
- Develop a strategy for testing diplopic patients
- Understand how to use prisms and image attenuation to mitigate diplopia

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Diplopia Assessment **Step 1...**

Does the double vision go away with an eye covered?

Optical causes of monocular diplopia	
Uncorrected astigmatism	
Lens surface reflections	
Incorrect bifocal placement	
Tear film abnormalities	
Corneal irregularity	
Iris abnormalities	
Cataract (lens abnormalities)	



Diplopia typically resolves with pinhole

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Step 1...

Diplopia Assessment **Step 1...**
Does the double vision go away with an eye covered?

Optical causes of monocular diplopia	Organic causes of monocular diplopia
Uncorrected astigmatism	Neurogenic disease
Lens surface reflections	Migraine
Incorrect bifocal placement	Epiretinal membrane
Tear film abnormalities	Choroidal neovascular membrane
Corneal irregularity	Macular edema
Iris abnormalities	
Cataract (lens abnormalities)	

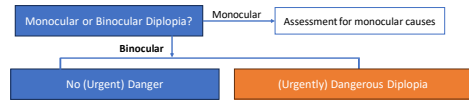


↓
Diplopia typically resolves with pinhole

Rutstein R., Vision Development and Rehabilitation, July 2017

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Diplopia Strategy



- What are likely causes of diplopia?
- History taking
 - What clues can we obtain from the history to help us classify the diplopia as dangerous or not?
 - How do we use the history to help us determine the etiology of the diplopia?
 - Clarifying patient goals.
- Diplopia Testing Strategy

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Why do patients develop binocular diplopia?

Decompensated phoria

- Fusional reserves no longer able to maintain phoria
- Typically gradual onset
- Can lead to constant diplopia



25A IAXT at distance and near



10A Hyperphoria/Intermittent Hypertropia

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Why do patients develop binocular diplopia?

Decompensated phoria

Childhood onset

- Unsuccessfully treated or recurring strabismus
- Change in magnitude of childhood onset strabismus



Consecutive ET with diplopia following exotropia surgery

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Why do patients develop binocular diplopia?

Decompensated phoria

Childhood onset (change in deviation)

Cranial Nerve Palsy

- Most common cause of sudden onset dip in patients 40-80yo (59% of these have an ischemic etiology)
- Patients under 40yo with CN palsy more likely due to trauma or neoplasm

(Comer et al. Eye 2007)

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Why do patients develop binocular diplopia?

Decompensated phoria

Childhood onset

Cranial Nerve Palsy

Mechanical restriction -Thyroid Eye Disease

- Engorgement of EOM's
- 90% will manifest lid retraction
- EOM Restriction in 40% of patients
- Most commonly restricts up gaze and abduction
- May cause hypotropia and vertical diplopia



Image courtesy of Dr. Bob Rutstein

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Why do patients develop binocular diplopia?

- Decompensated phoria
- Childhood onset
- Cranial Nerve Palsy
- Mechanical restriction (Thyroid Eye Disease)
- Neurological—MS, Myasthenia, brain tumor, Idiopathic
- Intracranial Hypertension



The right diagnosis is critical to determining the appropriate management. This begins with history taking...

BINO—limited adduction OU

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Clues from detailed history

Nature of diplopia...horizontal, vertical, oblique?

Horizontal	Problem with MR/LR	CN VI (LR Palsy) Convergence Insufficiency Decompensating eso/exo MG (if variable) Thyroid
Vertical/Oblique	Problem with elevators/depressors	CN IV (SO) CN III palsy Decompensating hyperphoria MG Thyroid (mechanical) Brainstem/cerebellar



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Clues from detailed history

Nature of diplopia...horizontal, vertical, oblique?
Worse at distance or near?



Worse at distance	Suggests difficulty with divergence	CN VI (LR Palsy) Decompensating eso/exo MG (if variable) Thyroid
Worse at near	Suggests difficulty with convergence	Convergence Insufficiency Partial CNIII—MR function MG (if variable)

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Clues from detailed history

Nature of diplopia...horizontal, vertical, oblique?
Worse at distance or near?
Worse in a particular gaze?



No change with gaze	Suggests comitant deviation	Decompensating phoria
Worse with change in gaze	Suggests incomitant deviation	CN palsy Mechanical restriction (Thyroid, trauma) Alphabet Pattern MG (if variable)

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Clues from detailed history

Nature of diplopia...horizontal, vertical, oblique?
Worse at distance or near?
Worse in a particular gaze?
When/how did the diplopia start? (sudden/gradual?)
Acute or longstanding?



} Sudden/acute onset more likely to be ischemic or traumatic.

Clues from detailed history

Nature of diplopia...horizontal, vertical, oblique?
Worse at distance or near?
Worse in a particular gaze?
When/how did the diplopia start? (sudden/gradual?)
Acute or longstanding?
Previous history of strabismus/eye turn?



↳ Previous history of patching as a kid?
Previous surgeries for eye turns?
History of "lazy eye"? } Perhaps the patient's eye turn has changed causing diplopia awareness?

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Clues from detailed history



Nature of diplopia...horizontal, vertical, oblique?
 Worse at distance or near?
 Worse in a particular gaze?
 When/how did the diplopia start? (sudden/gradual?)
 Acute or longstanding?
 Previous history of strabismus/eye turn?
 Is the diplopia stable throughout the day?
 What makes it worse/better?

} Diplopia fluctuating throughout the day may suggest MG/inflammatory processes

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Clues from detailed history



Nature of diplopia...horizontal, vertical, oblique?
 Worse at distance or near?
 Worse in a particular gaze?
 When/how did the diplopia start? (sudden/gradual?)
 Acute or longstanding?
 Previous history of strabismus/eye turn?
 Is the diplopia stable throughout the day?
 What makes it worse/better?
 Any other neurological signs/symptoms?

↳ Dizziness/Vertigo
 Ataxia
 Difficulty with balance
 Dysphagia
 Difficulty breathing

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Clues from detailed history



Nature of diplopia...horizontal, vertical, oblique?
 Worse at distance or near?
 Worse in a particular gaze?
 When/how did the diplopia start? (sudden/gradual?)
 Acute or longstanding?
 Previous history of strabismus/eye turn?
 Is the diplopia stable throughout the day?
 What makes it worse/better?
 Any other neurological signs/symptoms?
 Ischemic risk factors?
 If over 55yo, scalp tenderness, jaw claudication, fever, chills, weight loss, body pain? → GCA signs/symptoms?

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Assessing the Diplopic Patient

Acuity
VA Distance/near
Refraction if indicated

↳

E E Equalizing clarity and size of images will promote motor and sensory fusion.

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Assessing the Diplopic Patient

Acuity	
VA Distance/near	
Refraction if indicated	
Measures of Alignment and ocular motility	
CT Distance & Near	Through Hab Rx If Hab Rx has prism, also measure through TF without prism
CT in pertinent action fields	If history suggests incomitancy or CT suggests palsy
Maddox Rod or red lens	To aid in quantifying small deviations if indicated
EOms (versions)	Looking for over/under acting muscles
EOms (ductions)	Looking for mechanical restriction
Pursuits/saccades	Poor tracking may indicate supranuclear lesion

RT Gaze	SC Near	Left Gaze
5 RXT		3 RXT
4 RHT		2 RHT
5 RXT	4 RXT	Ortho
5 RHT	3 RHT	Ortho

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Ductions > Versions

Limited elevation Improved elevation monocularly

↳ Indicative of incomplete palsy

Ductions = Versions

Limited elevation No change monocularly

↳ Mechanical restriction or complete palsy

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Assessing the Diplopic Patient

Acuity	
VA Distance/near	
Refraction if indicated	
Measures of Alignment and ocular motility	
CT Distance & Near	Through Hab Rx If Hab Rx has prism, also measure through TF without prism
CT in pertinent action fields	If history suggests incomitancy or CT suggests palsy
Maddox Rod or red lens	To aid in quantifying small deviations if indicated
EOMs (versions)	Looking for over/under acting muscles
EOMs (ductions)	Looking for mechanical restriction
Pursuits/saccades	Poor tracking may indicate supranuclear lesion
Assessment of Fusion ability	
Stereo/W4Dot	If strabismic in primary, may consider with relieving prism
Vergence Reserves	BI/BO for eso/exo's and BI/BD for vertical deviations
Fusion with relieving prism	Can we eliminate diplopia with prism?

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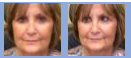
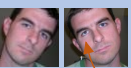

Assessing the Diplopic Patient

Acuity	
VA Distance/near	
Refraction if indicated	
Measures of Alignment and ocular motility	
CT Distance & Near	
CT in pertinent action fields	
Maddox Rod or red lens	
EOMs (versions)	
EOMs (ductions)	
Pursuits/saccades	
Assessment of Fusion ability	
Stereo/W4Dot	
Vergence Reserves	
Fusion with relieving prism	

Neuro	
Pupils	
VF screen (more detailed if indicated)	
Ocular Health Assessment	
Ant seg eval (ocular media)	
DFE/OCT (integrity of macula/ONH)	

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CN Palsies Causing Diplopia

Cranial Nerve Palsy	Clinical Presentation	Potential Etiologies
CNVI LR Palsy	 Limited abduction Horizontal diplopia Incomitant esotropia	Ischemic (pts >50yo) Neoplasm (higher risk in children) Trauma
CNIV SO Palsy	 Limited elevation Oblique Diplopia Elevation and excyclotorsion Hyper increase with head tilt toward affected side	Congenital (35-50%) Trauma (33-37%) Ischemic Rarely neoplasm
CNIII MR, SR, IR, IO, Levator	 Ptosis, limited elevation and adduction Oblique Diplopia Exotropia with hypotropia	Trauma (20%) Ischemic (15% adults) Neoplasm (15%) Congenital

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Tips for assessing CN palsy—CN IV (SO) Palsy



Image from Robert Rutstein's Atlas of Eye Disease

- CNIV weakness may result in hypertropia of affected eye
- Mild palsy may only show hypertropia in adduction (vertical phoria in primary)
- More severe palsy may show hypertropia in primary gaze

SO weakness most common cause for hyper deviation
ADULTS
Approx 1/3 → Congenital (35-50%)
Approx 1/3 → Trauma (33-37%)
Approx 1/3 → other causes
Rarely neoplasm
Trauma most common cause for bilateral SO palsy
<small>(Mullan et al, 2008)</small>
Children
Approx 50% → Congenital
Approx 37% → Trauma
Rarely neoplasm
<small>(Rapp, 2010)</small>

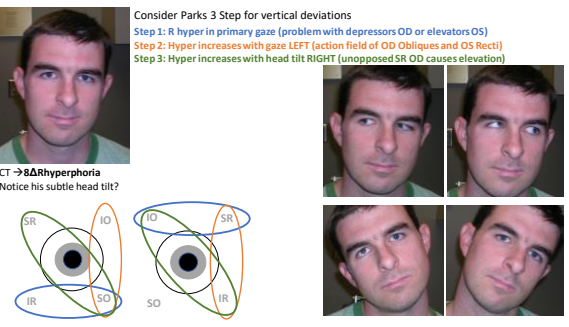
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Consider Parks 3 Step for vertical deviations

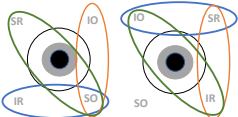
Step 1: R hyper in primary gaze (problem with depressors OD or elevators OS)

Step 2: Hyper increases with gaze LEFT (action field of OD Obliques and OS Recti)

Step 3: Hyper increases with head tilt RIGHT (unopposed SR OD causes elevation)



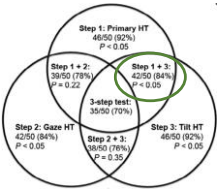
CT → 8Δ hyperphoria
Notice his subtle head tilt?



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Parks 2 Step test?

Studies of the sensitivity of the 3 Step Test have suggested it's not perfect...



50 SOP patients (confirmed by MRI) were tested with the Parks 3 Step Test

Performing all 3 steps was only 70% sensitive (it missed 30%)

- Step 2 was the most problematic
- not all SOP showed significant IOOA

Step 1+3 showed 84% sensitivity for correctly identifying SOP

If your patient has a hyper that gets worse with head tilt toward the hyper eye, it is likely a CN IV (SO) Palsy.

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Tips for assessing CN palsy—CN IV (SO) Palsy

If this patient is reporting new onset intermittent diplopia, how do we determine the etiology (is this dangerous)?

1/3 related to trauma
 History of head injury that coincides with onset of diplopia?
 Yes → R&R hyperphoria, Park's 3 step confirms RSOP. No further investigation needed. Initiate treatment for diplopia.

1/3 congenital
 Congenital SO weakness can decompensate over time and develop diplopia.
 Typically present with...
 • Habitual head tilt away from hyper eye (photos)
 • Extended vertical vergence ranges (>3.0)
 • Unclear Parks 3 step (spread of comitance)

1/3 ischemic, tumors, etc
 In the absence of trauma and/or clear evidence of longstanding SOP...
 >50yo with DM/HTN, Ischemia likely, if doesn't resolve in 3-6 months → Neuro/MRI
 <50yo and/or no ischemic risk factors, OR associated with other neuro signs including CN palsies → Neuro/MRI

Kline et al, Neuro-Ophthalmol. 2011

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Acquired SO Palsy Differentials

Skew Deviation—Vertical and torsional misalignment due to lesions of the vestibular or cerebellar structures

- Damage to one utricle causes the signals from the other utricle to increase
- The vestibulo-ocular system gets the message that the head is tilting
- Causes both eyes to rotate toward affected side causing torsion, vertical misalignment and head tilt

Skew Deviation	SO Palsy
Bilateral cyclotorsion toward lower eye (incyclo of higher eye, both eyes going same direction)	Monocular cyclotorsion with excyclotorsion of hyper eye
Typically associated with other neuro signs of ataxia and poor balance	No ataxia or issues with balance

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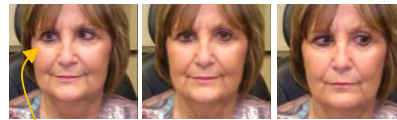
SKEW (OTR, ocular tilt reaction)
 Higher eye intorted, lower eye extorted
 Usually no or little torsional diplopia

IV (SUPERIOR OBLIQUE PALS)
 Higher eye extorted
 Torsional diplopia (images point to parietic eye)
 Slant (top of object appears closer)

Walsh and Hoyt's Clinical Neuro-Ophthalmology, 3rd Edition, 2016

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Tips for assessing CN palsy—CN VI (LR) Palsy



- Limited abduction on affected side
- Greater ESO at distance than at near
- Diplopia in field of defect (if late onset)
- Binocular vision usually preserved
- May present with head turn toward affected side

Image from Rutstein's Atlas of Oculomotor EV

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Tips for assessing CN palsy—CN VI (LR) Palsy

27yom—Diplopia when looking to right. Worsening since high school. MRI 5 years ago was clean. Uses compensatory head position.

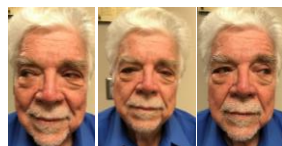


Limited abduction OD (ET in right gaze)

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Tips for assessing CN palsy—CN VI (LR) Palsy

When patient reports dip in left gaze but EOMs look pretty full...



Perform CT in Right and Left gazes to help identify abduction deficit...

RT Gaze	Left Gaze
Ortho	4° EP
	8° ILET



Consider using Red Lenses to help identify action fields with diplopia

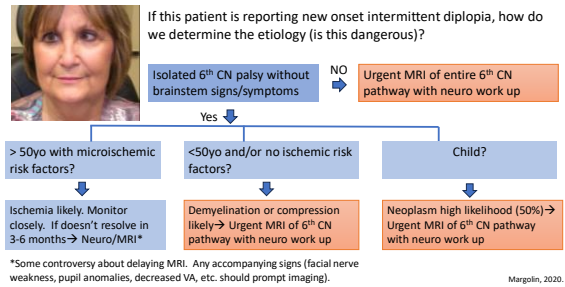
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Tips for assessing CN palsy—CN VI (LR) Palsy

Differentials for Abduction Deficit	
CN VI palsy	Abduction deficit similar on affected side in up and down gazes Ductions > Versions
Mechanical Restriction (Thyroid Eye Disease or Trauma)	Ductions = Versions (TED may cause tightening of MR)
Non-localizing muscle restriction secondary to increased intracranial pressure	May be associated with Papilledema and other neuro signs/symptoms

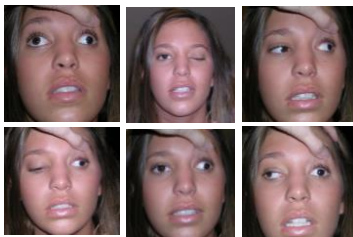
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Tips for assessing CN palsy—CN VI (LR) Palsy



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Tips for assessing CN palsy—CN III Palsy



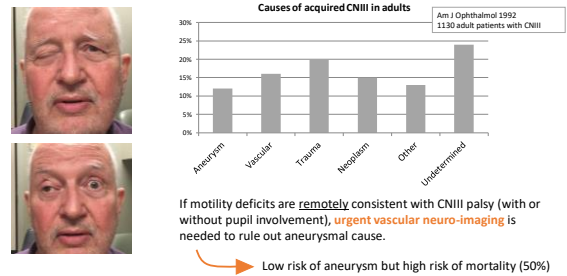
Complete CNIII
Affected eye presents **DOWN** and **OUT** (LR and SO only functioning muscles)

- Limited Adduction (MR)
- Limited Elevation (SR, IO)
- Ptosis (Levator)
- Mydriasis (variable)

CNIII Palsy secondary to trauma (MVA 12 months prior)
Symptoms?

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Tips for assessing CN palsy—CN III Palsy



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Tips for assessing CN palsy—CN III Palsy

Causes of Third Cranial Nerve Palsy in 49 Children (53 Eyes)

Cause	No. of Patients (No. of Eyes)		
	Partial Palsy	Complete Palsy	Total
Congenital	13 (13)	7 (7)	20 (20)
Trauma	7 (7)	8 (10)	15 (17)
Tumor	4 (4)	2 (2)	6 (6)
Vascular	3 (4)	1 (2)	4 (6)
Meningitis/encephalitis	3 (3)	0 (0)	3 (3)
Idiopathic	1 (1)	0 (0)	1 (1)
Total	31 (32)	18 (21)	49 (53)

63% Partial Palsy--37% Complete Palsy
41% Congenital (hypoplastic CNIII)
31% Trauma
1% Tumor
<1% Vascular



Schunacher-Faroo, 1999

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Identifying Dangerous Diplopia



- ▶ Sudden onset diplopia accompanied by **brainstem symptoms** require Urgent MRI
 - Dizziness/Vertigo
 - Ataxia
 - Difficulty with balance
 - Dysphagia
 - Difficulty breathing
- ▶ Sudden onset **non-isolated CN Palsy** (more than one CN) requires urgent MRI
- ▶ Sudden onset **CN III Palsy** requires urgent CTA (risk for aneurysmal compression)
- ▶ Sudden onset **CN VI Palsy** in <50yo and/or no microischemic risk requires urgent MRI
- ▶ Sudden onset **CN IV Palsy** in <50yo and/or no microischemic risk requires urgent MRI

Margolin, J of Neurological Sciences, 2020

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Identifying Dangerous Diplopia



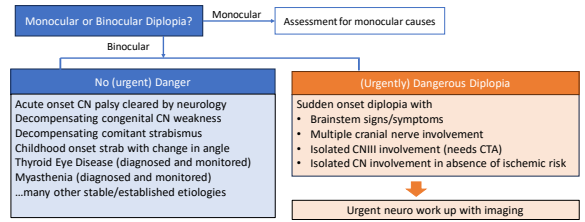
Children with acute diplopia

- Most common cause is headache (migraine)
 Higher risk of life-threatening (LT) etiology if the diplopia is also accompanied by...
- ▶ Ptosis (2.8 times greater risk LT)
 - ▶ Strabismus (2 times greater risk LT)
 - ▶ Other neuro signs (ataxia, speech disorder, cerebellar signs...2.5 times greater risk LT)
 - ▶ Vomiting (1.7 times greater risk)
 - ▶ Urgent ED Referral

Italian study of children reporting to ER over 6 year period
 (Rausci et al. Euro J Paediatric Neuro. 2017)

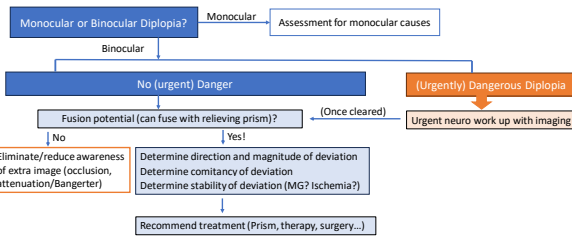
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Diplopia Strategy



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Diplopia Strategy



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This patient has double vision...



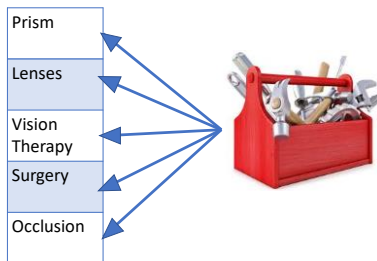
1 month history of horizontal diplopia following cerebellar stroke. More frequent dip at distance than near. Some difficulty with balance (working with PT). Symptoms slowly improving. Pt would like to drive without diplopia.

BCVA (with CLs)	20/20 OD and OS	
CT @ Distance	12Δ ILET	Eso Distance > Eso Near
CT @ Near	8Δ EP at near	Consider CNVI palsy
EOMs	Full motility	No apparent abduction deficit (?)
Stereo	Ductions = Versions	
	40 sec	

How do we mitigate his diplopia at distance?
 We expect he has normal fusion potential...

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Diplopia (BV) Toolbox



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Diplopia (BV) Toolbox



Prism		
Compensating Prism	Prism amount equal to strabismic deviation Example: Rx 20ΔBO for 20Δ Esotropie	Works best for comitant deviations with equal magnitude at distance & near
Relieving Prism		
Yoked Prism		

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Diplopia (BV) Toolbox



Prism		
Compensating Prism	Prism amount equal to strabismic deviation Example: Rx 20ΔBO for 20Δ Esotropie	Works best for comitant deviations with equal magnitude at distance & near
Relieving Prism	Prism amount partially corrects strabismic deviation (least amount of prism necessary to eliminate diplopia) Example: Rx 12ΔBO for 20Δ Esotropie	Works best for comitant deviations with equal magnitude at distance & near with some vergence reserves
Yoked Prism		

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Diplopia (BV) Toolbox



Prism		
Compensating Prism	Prism amount equal to strabismic deviation Example: Rx 20ΔBO for 20Δ Esotropie	Works best for comitant deviations with equal magnitude at distance & near
Relieving Prism	Prism amount partially corrects strabismic deviation (least amount of prism necessary to eliminate diplopia) Example: Rx 12ΔBO for 20Δ Esotropie	Works best for comitant deviations with equal magnitude at distance & near with some vergence reserves
Yoked Prism	Prism Rx Used to to shift patient's gaze away from diplopic field of view. Base direction is equal for both eyes and oriented toward diplopic field. Example: Rx BO OD, BI OS (BASE RIGHT OU)	Works best for incomitant deviations with mild compensating head position that allows for fusion.

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Diplopia (BV) Toolbox



Prism	Relieving prism —best for comitant, low AC/A, Eso's and hyper deviations. Yoked Prisms best for incomitant deviations with compensating head position
Added Lenses	
Vision Therapy	
Surgery	
Occlusion	

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Added Lenses

Added Plus at near

High AC/A Eso

- Convergence Excess ET
- Basic Eso?

Reading Rx or Add




Added Minus at distance

High AC/A Exo → Divergence Excess XT

- Added Accommodative effort may help control XT
- Better tolerated by young XT's (who are rarely diplopic)

Increases risk of becoming myopic



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Vision Therapy

- Consider for small to moderate intermittent strabismus with fusion potential
- Train compensating vergence ranges to improve strabismus control and eliminate diplopia
- More commonly prescribed for Exotropia
- Effective for managing diplopia from convergence insufficiency IXT



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Surgery



- Treatment of choice for
- Large angle, high frequency strabismus
 - Difficult to manage with ground prism
 - Difficult to manage with therapy
 - Highly incomitant deviation
 - Patients with significant torsion
 - Stable deviation (present 6-12 months)
 - Ischemic CN Palsy's may resolve with time

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Occlusion

- Patients with intractable diplopia (cannot fuse images)
- Incomitant deviation with variable diplopia
- Diplopia that cannot be managed with other treatment options
- Occlusion options
 - Complete Occlusion with opaque patch or contact lens (opaque or over plused)
 - Attenuation of image with Bangerter Foil



Silverberg et al. Archives of Ophthalmol 1999

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Diplopia (BV) Toolbox



Prism	Relieving prism—best for comitant, low AC/A, Eso's and hyper deviations. Yoked Prisms best for incomitant deviations with compensating head position
Added Lenses	Added Plus—High AC/A Eso's at near, reading Rx or add power Added Minus—High AC/A Exo's at distance, better for very young pts but increases risk of myopia.
Vision Therapy	Training Vergence Reserves—Small to moderate angle, intermittent strabismus with fusion potential. More commonly prescribed for Exo's (CI-IXT)
Surgery	Strabismus that is high frequency and large angle and/or large incomitance. Must be a stable deviation (present 6-12 months).
Occlusion	Complete occlusion with an opaque patch/CL or attenuation with Bangerter Foil for diplopia that cannot be managed with other tools

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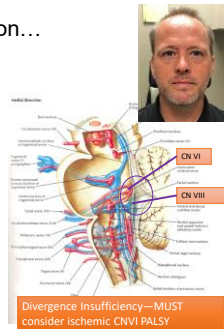
Back to our patient with double vision...

1 month history of horizontal diplopia following cerebellar stroke. More frequent dip at distance than near. Some difficulty with balance (working with PT). Symptoms slowly improving. Pt would like to drive without diplopia.

VA: 20/20 OD/OS with CL's
Cover Test: 12Δ ILET at distance
8Δ EP at near



Angle similar magnitude distance and near with mild incomitance...consider Fresnel prism?



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How Much Prism to Rx

Is the patient diplopic? → YES! → While patient is diplopic, add prism in the direction of the deviation until single vision is obtained.



↓
Consider starting with least amount of prism needed to eliminate double vision.

Fusion Prism Criteria

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Our diplopic esotrope...

May	12Δ ILET @ distance 8Δ EP @ Near	Fusion found with 8Δ at distance and near Applied 8Δ BO Fresnel for specs
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Our diplopic esotrope...

May	12Δ ILET @ distance 8Δ EP @ Near	Fusion found with 8Δ at distance and near Applied 8Δ BO Fresnel for specs
June	Through Fresnel: XP at dist No prism: 6-8Δ CAET @ dist No prism: 6Δ EP @ near	Fusion found with 6Δ BO prism Applied 6Δ BO Fresnel for specs



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Our diplopic esotrope...



May	12Δ ILET @ distance 8Δ EP @ Near	Fusion found with 8Δ at distance and near Applied 8Δ BO Fresnel for specs
June	Through Fresnel: XP at dist No prism: 6-8Δ CAET @ dist No prism: 6Δ EP @ near	Fusion found with 6Δ BO prism Applied 6Δ BO Fresnel for specs
July	Through Fresnel: 2XP D&N No prism: 4Δ CAET @ dist No prism: 6Δ EP @ near	Fusion found with 4Δ BO prism Applied 4Δ BO Fresnel for specs

61

Our diplopic esotrope...

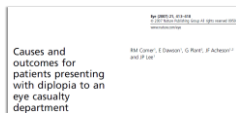


May	12Δ ILET @ distance 8Δ EP @ Near	Fusion found with 8Δ at distance and near Applied 8Δ BO Fresnel for specs
June	Through Fresnel: XP at dist No prism: 6-8Δ CAET @ dist No prism: 6Δ EP @ near	Fusion found with 6Δ BO prism Applied 6Δ BO Fresnel for specs
July	Through Fresnel: 2XP D&N No prism: 4Δ CAET @ dist No prism: 6Δ EP @ near	Fusion found with 4Δ BO prism Applied 4Δ BO Fresnel for specs
August	Through Fresnel: Ortho No Prism: 2ΔEP @ dist, ortho at near "Can wear old Rx w/o prism for short periods"!	Subjectively reported more comfortable vision with 2Δ BO than without prism. Applied 2Δ BO and encouraged to remove prism as able.

62

Ischemic CN VI Palsy

- Eye hospital referrals for diplopia—165 patients
- CN Palsy most common cause of acute diplopia (67%)
 - CNVI was most commonly affected nerve
 - Ischemic CN palsies typically improve with time
 - 87% spontaneously resolved within 5 months
 - 95% resolution within 12 months



Comer, Eye, 2007

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Ischemic CN VI Palsy

- Manage diplopia in primary gaze with BO Fresnel prism for first 6 months
- Needed prism will likely be close to full deviation magnitude
- Titrate prism as needed to maintain least prism needed
- Esotropia persisting beyond 6-12 months
 - Consider ground prism for deviations 10-12Δ
 - Consider surgical consult for stable deviations ≥15Δ

64



54yo with intermittent vertical diplopia

Intermittent double vision while driving and on the computer. Worse when tired and gradually increasing in frequency.

20/20 OD and OS with Hab Rx -2.50 OU

CT @ Distance	6° LHyperP, 2XP
CT @ Near	8° LHyperP, 6 XP
EOM's	IOOA OU, L SOUA V Pattern Exo

Left Hyper in primary gaze
Increases in Right gaze...suspect CNIV weakness.

65



54yo with intermittent vertical diplopia

Intermittent double vision while driving and on the computer. Worse when tired and gradually increasing in frequency.

CT @ Distance	6° LHyperP, 2XP
CT @ Near	8° LHyperP, 6 XP
EOM's	IOOA OU, L SOUA V Pattern Exo

Left Hyper in primary gaze
Increases in Right gaze
Increases with Left Tilt
Consistent w CNIV weakness.

Vertical Vergence Ranges
BD OS @ D: X/16/14
BU OS @ D: x/1/0

Does this patient need imaging?
Would he benefit from a vertical prism Rx?

66

54yo with intermittent vertical diplopia
 Intermittent double vision while driving and on the computer. Worse when tired and gradually increasing in frequency.

CT @ Distance	6° LHyperP, 2XP
CT @ Near	8° LHyperP, 6 XP
EOM's	IOOA OU, L SOUA V Pattern Exo

Left Hyper in primary gaze
 Increases in Right gaze
 Increases with Left Tilt
 Consistent w CNIV weakness.

Vertical Vergence Ranges
 BD OS @ D: X/16/14
 BU OS @ D: x/1/0

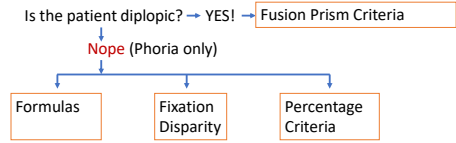
Consistent with decompensating SO palsy

- Longstanding, intermittent diplopia
- Vertical vergence ranges >>3Δ
- No history of trauma or vasculopathic risk factors

How do we determine prism RX?

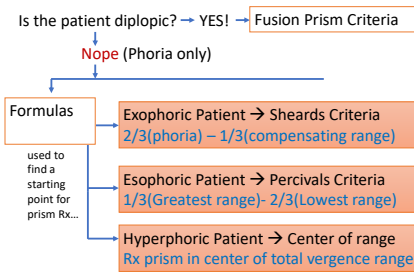
67

How Much Prism to Rx



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How Much Prism to Rx



69

Using formulas to prescribe BI prism for CI patients

This 12yo reported frequent diplopia at near due to CI/IXT. Poor responder to VT. Opted to Rx reading glasses with BI prism...

Distance CT	2 XP
Near CT	14 IAXT (trope 30%)
PFV @ near	X/16/8
NPC	5/7cm



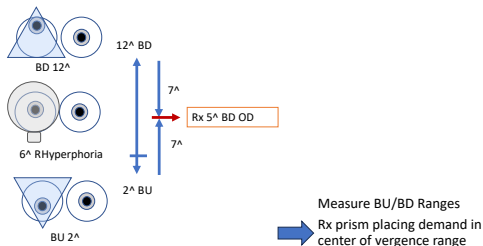
$$\begin{aligned} [2/3(14) - 1/3(16) = \\ 9.3333 - 5.3333 = \\ 4\Delta \text{ BI Prism} \end{aligned}$$

Sheard's Criteria for prescribing prism
 Prism Rx = $2/3(\text{phoria}) - 1/3(\text{compensating vergence range})$



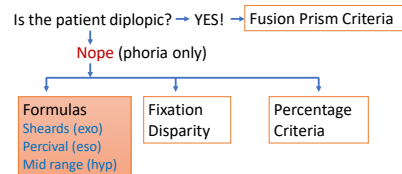
70

Using formulas to prescribe prism for hyperphoric patients



71

How Much Prism to Rx

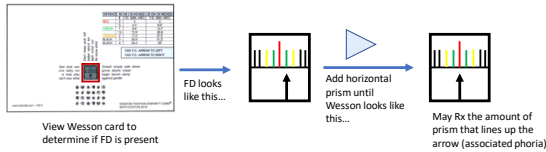


72

Fixation Disparity to RX **Horizontal** Relieving Prism

If the patient has horizontal fixation disparity, consider using associated phoria value as starting point for Prism Rx

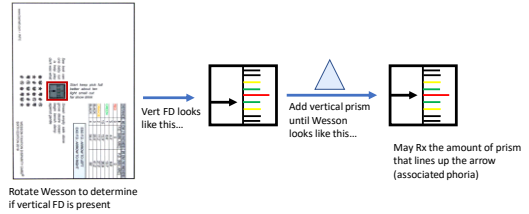
- May be done with FD card introducing lateral prism until the horizontal FD is eliminated (associated phoria)



73

Fixation Disparity for **Vertical** Relieving Prism

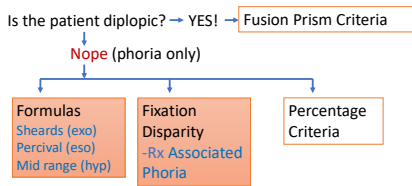
If the patient has vertical Fixation Disparity, find the vertical associated phoria using the FD card introducing vertical prism until the vertical FD is eliminated



Wesson Fixation Disparity Card—Bennell.com (\$59.00)

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How Much Prism to Rx



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Residual Vergence Demand Criteria

Angle of presenting deviation	Rx Prism leaving this amount uncorrected
6-20Δ Eso Deviation	Leave 4-6Δ uncorrected
3-10Δ Hyper Deviation	Leave 2-4 Δ uncorrected
20-30Δ Exo Deviation	Leave 10-15Δ uncorrected

Doesn't give guidelines for deviations less than those specified

Amounts based on clinical wisdom...arbitrary

Suggests...

- Eso's and hyper's may require prism closer to the full angle of deviation
- Exo's need less compensating prism than eso's and hyper's

Calaroso and Rouse; Clinical Management of Strabismus, 1993

76

Percentage Criteria

Direction of phoria	Amount of prism to Rx	Example
Exo	Approximately 1/3 of the phoria amount	12Δ XP, give 4Δ BI
Eso	Between 1/2 to the entire phoria amount	12Δ EP, give between 6Δ and 12Δ BO
Hyper	Between 1/2 to the entire phoria amount	4Δ R hyper, give between 2Δ and 4Δ split

Based on clinical experience...arbitrary

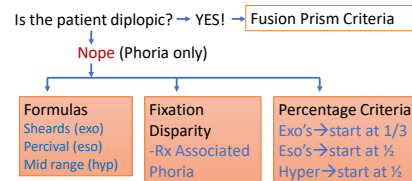
Suggests...

- Eso's and hyper's may require prism closer to the full angle of deviation
- Exo's need less compensating prism than eso's and hyper's

Griffin and Grisham, Binocular Anomalies Diagnosis and Therapy, 3rd ed. 1995

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How Much Prism to Rx



78

54yo with intermittent vertical diplopia

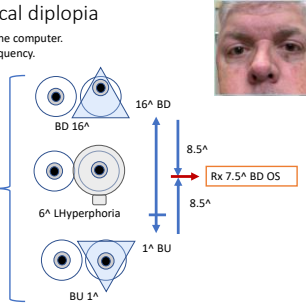
Intermittent double vision while driving and on the computer.
Worse when tired and gradually increasing in frequency.

CT @ Distance	6 ^Δ LHyperP, 2XP
CT @ Near	8 ^Δ LHyperP, 6 XP
EOM's	IOOA OU, L SOUA V Pattern Exo

Determining the Prism Rx using Formulas...

Vertical Vergence Ranges
BD OS @ D: X/16/14
BU OS @ D: x/1/0

If your patient can perform vertical vergence ranges, find midpoint of vertical vergence range.



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54yo with intermittent vertical diplopia

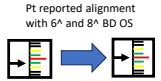
Intermittent double vision while driving and on the computer.
Worse when tired and gradually increasing in frequency.

CT @ Distance	6 ^Δ LHyperP, 2XP
CT @ Near	8 ^Δ LHyperP, 6 XP
EOM's	IOOA OU, L SOUA V Pattern Exo

Determining the Prism Rx using Fixation Disparity...
If the patient has vertical Fixation Disparity, determine the amount of prism that eliminates the FD (find the associated phoria).

Associated Phoria: 6-8^Δ BD OS

Viewing the Wesson Card (rotated)...



Pt reported alignment with 6^Δ and 8^Δ BD OS

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54yo with intermittent vertical diplopia

Intermittent double vision while driving and on the computer.
Worse when tired and gradually increasing in frequency.

CT @ Distance	6 ^Δ LHyperP, 2XP
CT @ Near	8 ^Δ LHyperP, 6 XP
EOM's	IOOA OU, L SOUA V Pattern Exo

Determining the Prism Rx using Percentage Criteria...
If the patient does not have vertical Fixation Disparity, and/or cannot perform vertical vergence ranges, use the percentage criteria as a starting point.

Direction of phoria	Amount of prism to Rx
Hyper	Between 1/2 to the entire phoria amount

Using Distance CT (smaller of two deviations), Rx between 3Δ to 6Δ BD OS



81

54yo with intermittent vertical diplopia

Intermittent double vision while driving and on the computer.
Worse when tired and gradually increasing in frequency.

CT @ Distance	6 ^Δ LHyperP, 2XP
CT @ Near	8 ^Δ LHyperP, 6 XP
EOM's	IOOA OU, L SOUA V Pattern Exo

Determining the Prism Rx...

Vertical Vergence Ranges
BD OS @ D: X/16/14
BU OS @ D: x/1/0

Near measures { Formula: Rx 7.5^Δ BD OS
Associated Phoria: Rx 6-8^Δ BD OS }
Distance → Percentage Criteria: Rx 3^Δ - 6^Δ BD OS

Opted for 6^Δ of prism (did not want to exceed maximum prism needed for distance) and split unequally placing more prism before weaker eye...

Rx: -2.50 c 2^ΔBU OD
-2.50 c 4^ΔBD OS
+2.50 add



82

Grinding Prism...to split or not to split?

Split prism equally	for comitant, non-paretic, non-restrictive deviations between 2 ^Δ - 12 ^Δ (ish).
Split prism unequally	for mildly paretic, non-restrictive deviations between 2 ^Δ - 12 ^Δ (ish) Place slightly more power before eye with muscle weakness
Do not split prism	for complete paresis or restrictive deviations between 1 ^Δ - 7 ^Δ (ish) Place entire prism power before eye with muscle weakness or restriction
Additional prism Rx'ing Considerations...	<ul style="list-style-type: none"> Maximum prism per lens = 6-7Δ (index, lens size, power...) Don't split prism less than 2Δ

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Prescribing Prism

Vertical Prism

- When vertical phoria is present consider vertical prism before lateral prism
- Vertical associated phoria is most widely used method for determining prism power (find prism that eliminates FD)
- If no Vertical FD present, Rx middle of vertical verg range
- If unable to measure vertical vergence range, consider rx'ing between 1/2 of the deviation up to the full magnitude of the deviation
- Final prism power may be equal to deviation (hypers like prism)
- When possible, trial Fresnel prism before making final Rx

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Prescribing Prism

Esophoria

- Eso's will generally accept prism better than exo's
- Eso's will generally take a prism power closer to phoria measure than exo's (½ of deviation up to full amount)
- May begin with Percival's or associated phoria and tweak
- When possible, use Fresnel trial before final Rx

Exophoria

- Generally, need lower percentage of phoria compensation with prism (1/3 to ½ of deviation)
- Don't typically respond as favorably to prism as eso's and hypers
- May begin with Sheard's or associated phoria and tweak
- When possible, trial Fresnel prism before final Rx

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Thoughts on Fresnel Prism

- Excellent for...** ❤️
- Ischemic deviations likely to change with time
 - Prism trial...allows them to test drive and tweak as needed before you grind
 - Patients needing prism in only one gaze or location (easy to cut prism any shape or orientation)
 - Patients unable to obtain specs with ground prism
 - Providing quick, inexpensive, in-office treatment for diplopia management



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Thoughts on Fresnel Prism

Drawbacks to Fresnel...

- Not great for long term use (get grimy and brittle over time)
- Patients often bothered by lines on glasses and glare from the prisms (warn your patients)
- Higher prism powers (>10^Δ) degrade VA



BO Fresnel prism OS for basic IET. Patient returned 18 months later with same Fresnel!

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Severely limited elevation and abduction OU

62yo with history of TED

Seeing double at distance, no diplopia at near.
 CT @ Dist: 18-35 CLET (with diplopia)
 CT @ Near: 25 EP

Diplopia relieved with 12^ΔBO at distance.
 No tx for near (FD=0 and patient asymptomatic).

Placed 12^ΔBO Fresnel on left lens of specs.

(Also noted significant chin up head posture at this exam which improved with 12BO)

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Severely limited elevation and abduction OU

62yo with history of TED

4-6 weeks later...Patient reports improved function since baseline visit after adjusting the Thyroid meds. Patient returned with Rx with Fresnel complaining about distance vision in the eye with Fresnel (20/70).

Happy with dip management/relief from glasses. Only uses the glasses in the morning when her dip is the worst.

CT @ D without prism: 18-20 EP! (no strab)
 CT @ N without prism: 25 EP
 CT @ D with 12^Δ BO prism: 6-8 EP

Elected to grind the 12BO (split)

Bilateral abduction deficit allowed us to place 6^ΔBO in each eye

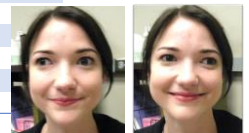
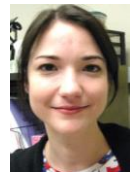
89

Andrea

26yo female

Longstanding intermittent outward eye turn with diplopia. Eye strain. Blurry vision with Hab -5.75 CL's (even though doc told her CL rx was correct).

VA w CL's	20/25 OD, OS, OU
CT @ Distance	30Δ IAXT (<10%)—fluctuates and reports blurry vision at dist when eyes aligned
CT @ near	25 XP
MEM	Plano and stable
PFV's distance	X/26/20
PFV's near	X/25/16
Stereo	20 seconds of arc



90

Andrea

26yo female

Longstanding intermittent outward eye turn with diplopia. Eye strain. Blurry vision with Hab -5.75 CL's (even though doc told her CL rx was correct).

VA w CL's	20/25 OD, OS, OU
CT @ Distance	30Δ IAXT (<10%)—fluctuates and reports blurry vision at dist when eyes aligned
CT @ near	25 XP
MEM	Plano and stable
PFV's distance	X/26/20
PFV's near	X/25/16
Stereo	20 seconds of arc

Treatment Options...

- Prism?
- Over minus?
- Therapy?
- Surgery?

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Andrea

Amazing control but suspected she was using accomm to pull her eyes inward
Discussed Surgery vs. VT...patient wanted to try VT
After 10 visits of OLYMPIC level VT skill...

VA w CL's	20/25 OU
CT @ Distance	45XP/IXT (<10%)
CT @ Near	40XP
PFV @ Distance	35/45/40
PFV @ Near	20/45+/45
NPC	TTN



Improved vergence ranges but still not enough to control XT
Over minus her CL's?

Still bothered by IXT and intermittent blur...

92

Andrea

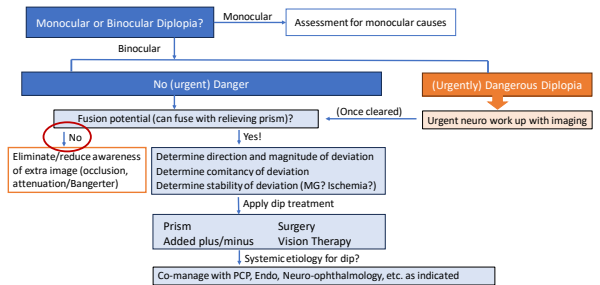
Adult Divergence Excess/Basic Exo IXT with diplopia

- Angle too large for prism
- Angle too large to comfortably control with VT
 - Many DE IXT's do well with therapy...this one was too big
- Patient is old to comfortably use over minus Rx (she rejected -0.50 to -1.00 over her CL's)
- Ultimately referred for surgery to reduce magnitude of deviation
 - Patient then moved to California...but emailed to say she no longer had diplopia and was doing well with treatment!



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Diplopia Strategy



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73yo female with diplopia

Referred from surgeon to determine if she would benefit from EOM sx

Careful History:

- History of "lazy" OD with hx of patching and VT, no surgery (RSO Palsy from Sx records)
- Something happened to the right eye causing a "cloud" which was treated by retinal surgeon
- Same "cloud" thing happened to OS (preferred eye) 1 year ago and that's when diplopia started
- Diplopia is constant and diagonal—closes an eye to eliminate double vision
- Prism glasses make visual distortions and diplopia more noticeable
- Prefers to read with +3.00 OTC Readers (closes her left eye)
- Pseudophakic OU

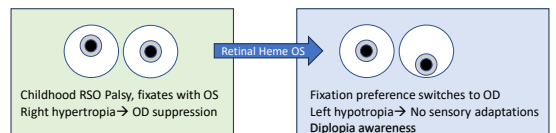
Hab Rx:		Distance CT w/o prism	30Δ Lhypotropia w 8ΔLXT
+0.75-0.50x100	4Δ BD Prism	Distance CT w/Prism Rx	20Δ Lhypotropia
-0.50	4Δ BU Prism	Near CT w/+3.00 readers	25Δ Lhypotropia w 10ΔLXT

8Δ prism for Rhyper/Lhypo

Patient fixating with RIGHT (non-preferred) eye
FIXATION SWITCH DIPLOPIA

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Fixation Switch Diplopia



Distance CT w/o prism	30Δ Lhypotropia w 8ΔLXT
Distance CT w/Prism Rx	20Δ Lhypotropia
Near CT w/+3.00 readers	25Δ Lhypotropia w 10ΔLXT

Patient fixating with RIGHT (non-preferred) eye
FIXATION SWITCH DIPLOPIA

Does she have fusion potential?

96

73yo female with diplopia

Referred from surgeon to determine if she would benefit from EOM sx

Hab Rx:			Distance CT w/o prism	30Δ Lhypotropia w 8ΔLXT
+0.75-0.50X100	4Δ BD Prism	20/25	Distance CT w/Prism Rx	20Δ Lhypotropia
-0.50	4Δ BU Prism	20/25	Near CT w/+3.00 readers	25Δ Lhypotropia w 10ΔLXT

8Δ prism for Rhyper/Lhypo

Patient fixating with RIGHT (non-preferred) eye
FIXATION SWITCH DIPLOPIA
Does she have fusion potential?

Trial of relieving prism (BU OS)—Unable to provide stable fusion with prism

Synoptophore Testing—After aligning large 2nd degree target with foveas (20Δ OS), pt reports good overlapping of targets but left image is distorted

→ Foveal distortion prohibits fusion → Poor candidate for surgery or additional prism

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Diplopia with poor fusion potential

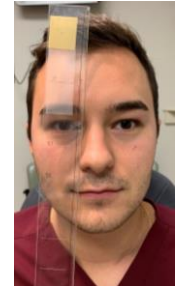
Consider Bangarter Occlusion Foils



Bangarter adheres to back of lens

Filter Density	Predicted VA
LP	LP
<0.1	20/300
0.1	20/200
0.2	20/100
0.3	20/70
0.4	20/50
0.6	20/30
0.8	20/25

Different densities degrade VA to desired level



Bangarter Filter Bar used to determine needed density

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73yo female with diplopia

Referred from surgeon to determine if she would benefit from EOM sx

Hab Rx:			Distance CT w/o prism	30Δ Lhypotropia w 8ΔLXT
+0.75-0.50X100	4Δ BD Prism	20/25	Distance CT w/Prism Rx	20Δ Lhypotropia
-0.50	4Δ BU Prism	20/25	Near CT w/+3.00 readers	25Δ Lhypotropia w 10ΔLXT

8Δ prism for Rhyper/Lhypo

Patient fixating with RIGHT (non-preferred) eye
FIXATION SWITCH DIPLOPIA

→ We opted to try a Bangarter Foil to eliminate the diplopic image. She reported reading through her OTC reading RX with the 0.1 density filter made reading "much easier".

→ Notes back to referring surgeon discouraging surgical correction of Left Hypotropia (bringing diplopic images closer together was bothersome!)

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Crafty Bangarter applications...

78yo male with history of diplopia following a fall with a head injury.



Diplopia in primary gaze eliminated with application of Bangarter on central portion of lens.

Referred by surgeon after strabismus surgery and prism had failed to provide fusion.

Patient struggling with TV/computer and reading

CT: 6^Δ CRET w 6^Δ CRHperT

Unable to fuse with prism.

100

Crafty Bangarter applications...

56yo female with history of diplopia in LEFT gaze following MVA in 2012

Wearing 3Δ BO prism ground in specs for IET following MVA

Excellent VA (20/20) with fusion in primary and right gazes with prism

Aware of horizontal diplopia in left gaze

Right Gaze	Primary Gaze	Left Gaze
4Δ EP/IET	4Δ EP	8Δ CLET

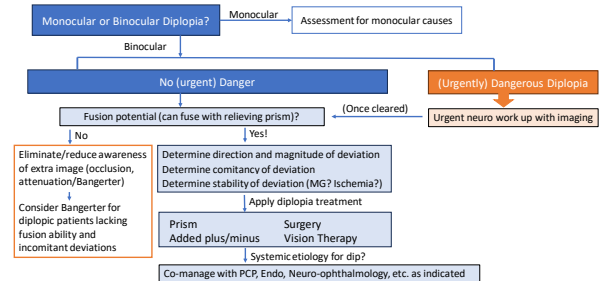
Tried BO Fresnel prism on left side of Left lens...



Diplopia in left gaze eliminated with application of Bangarter on left side of left lens.

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Diplopia Strategy



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