Hands-on workshop utilizing the prism cover test and prism therapeutics for the diplopic patient

NANOS 2015
Introduction:
Evaluation of the diplopic patient is time consuming, demanding and frustrating.
Understanding how to perform the prism cover test, determining fusional amplitudes, differentiating phoria from tropia, use of the PAT, placing press on prisms and prescribing prisms is an art.
Goals:

Explain the evaluation of diplopic patients where prisms are useful in diagnosis and treatment

Compare different types of prisms available and their utility in examining and treating patients with diplopia

Describe the different prism cover tests and their use in differentiating phoria from tropia.
Faculty:
Shelley Klein, CO – 4th and 6th nerve palsy
Erika Acera, CO – Thyroid orbitopathy
Shira Robbins, MD – Divergence insufficiency
David Granet, MD – Convergence insufficiency
Mitchell Strominger, MD – Diplopia following cataract extraction

No financial disclosures

Shira Robbins, MD
- AAP - Royalties
- US Dept Health and Human Services - Consultant
- Allergan – Consultant
- Retrophin – Advisory Board

Equipment discussed and demonstrated is purely operational and not promotional
Special Thanks!

Lloyd Powell,
President
Richmond Products

Bianca Granado
Marketing Manager
Richmond Products

Kathy Armstrong
President
Fresnel Prism and Lens Company
The Prism Cover Test

Neutralization of deviation with prisms by optically moving the image onto the fovea
The Prism

• Triangular or wedge shaped piece of refracting material
• Thickest edge of the prism → **BASE**
• Thinnest edge of the prism → **APEX**
• A prism changes the direction of light without changing it’s focus
• Prism is created when the front surface is not parallel to the back surface
The Prism

Prism is measured in units called “prism diopters (pd)”
Defined as 1pd yields a deviation of 1cm @ 1M.
In viewing an object through a prism, the image is
displaced toward the apex.
On the retina, the image is moved towards the base.
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In viewing an object through a prism, the image is displaced toward the *apex*. On the retina, the image is moved towards the *base*.
The Cover Test

Prerequisites for a reliable *Cover Test*
- eye movement capability
- image formation and perception
- foveal fixation in each eye
- eliminating accommodative influences
- attention and cooperation

Most effective way to suspend fusion
Each eye should be occluded at least 2 secs
Types of Cover Tests

Cover/Uncover - aka: Single Cover Test (SCT)

Performed first
Monocularly
Used to determine if a manifest strabismus is present
Differentiate between a tropia (manifest deviation) and a phoria (latent deviation)
Types of Cover Tests

Simultaneous Prism Cover Test (SPCT)
Measures the angle under normal binocular conditions
As the occluder covers the fixing eye, prisms are placed in front of the deviated eye at the same time to neutralize turn
Most useful with Accommodative Esotropia and Monofixation Syndrome (usually angle < 10pd)
Patient may be demonstrating partial control over a coexisting heterophoria through peripheral fusion binocularly.
“Cosmetic deviation”
Types of Cover Tests

Prism Cover Test (PCT)
  a.k.a. Alternate Prism Cover Test (APCT)
  Measures the total deviation (manifest and latent components)
  Patients should not be allowed to establish binocularity
  Tested at distance (6M) and near
  Measurements at Near should include primary position and downgaze. (Measure through bifocal if present)
  Measurements at Distance should include primary position plus
    Side gazes to determine the presence of any lateral incomitance
    Upgaze and downgaze to determine the presence of A or V patterns
    If vertical is present head tilt R and L should be performed
    If oblique dysfunction is present or suspected measure in the oblique positions
Different Prism Options

A. Loose prisms

B. Horizontal and Vertical Prism Bars

C. Fresnel Prism Trial Set
Alternate Prism Cover Test

Deviation is measured using prisms

The *apex* of the prism is pointed towards the *deviation*

- Esotropia - LET
- Exotropia - LXT
- Left Hypertropia - LHT
- Left Hypotropia - LHypoT

| Base OUT - BO | Base IN - BI | Base DOWN - BD | Base UP - BU |

Thereby the *base* will be in the opposite direction.
Image falls on **nasal** retina and is perceived as coming **temporally**.
Adding Base OUT prism moves the image in space towards the \textit{apex}.

While moving the image on the retina towards the \textit{base}.
During PCT, as BO prism is added, the newly uncovered eye will move to pick up fixation. Neutralization of the turn is achieved when the correct amount of prism moves the image onto the fovea. Thereby eliminating the need for refixation.

This amount of prism needed is the measurement of the deviation.
Factors affecting prism and cover measurements

- Hold prisms in frontal plane position
Correct Frontal Plane Placement of Prism

Right gaze (head turned L)

Primary position

Left gaze (head turned R)
Incorrect Prentice Placement of Prism

Right gaze

Left gaze
Factors affecting prism and cover measurements

- Hold prisms in frontal plane position
- High refractive errors > 5D
Factors affecting prism and cover measurements

• Hold prisms in frontal plane position

• High refractive errors > 5D

• Stacking prisms > 20 pd, better to split between 2 eyes, OK to stack vertical and horizontal prism < 20pd otherwise, recommend splitting.
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• Hold prisms in frontal plane position

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• Stacking prisms > 20 pd, better to split between 2 eyes, OK to stack vertical and horizontal prism < 20pd otherwise, recommend splitting.

• Primary and Secondary deviations
  1° Fix with non-paretic eye / prisms over paretic eye / are smaller
  2° Fix with paretic eye / prisms over non-paretic eye / are larger
Primary and Secondary Deviations

Seen in paralytic or restrictive strabismus

Occurs when patient is fixating with the paralytic and/or restricted eye

2° deviations are larger because it takes greater innervation for the paretic/restricted eye to fix on a target

By Hering’s law, an equal amount of innervation is going to the contralateral yoke muscle

1° Fix with non-paretic eye/prisms over paretic eye/smaller

2° Fix with paretic eye/prisms over non-paretic eye/larger
Factors affecting prism and cover measurements

- Hold prisms in frontal plane position
- High refractive errors > 5D
- Stacking prisms > 20 pd, better to split between 2 eyes, OK to stack vertical and horizontal prism < 20pd otherwise, recommend splitting.
- Primary and Secondary deviations
  1° Fix with non-paretic eye / prisms over paretic eye
  2° Fix with paretic eye / prisms over non-paretic eye
- **Angle Kappa**
  Positive angle simulates an XT
  Negative angle simulates an ET
Angle Kappa......may simulate a strabismus

It is the angle formed by the pt’s visual and pupillary axes

Visual axis = line of sight connecting the fixation target to the fovea

Pupillary axis = the line that passes perpendicular to the center of cornea

When the corneal light reflex is displaced......

Nasally = Positive angle simulates an XT
Temporally = Negative angle simulates an ET
Angle Kappa Generalizations

Positive angle kappa is most common

Negative angle kappa is more common in high myopes

Most angle kappas are physiologic especially in emmetropes and hyperopes (1.4 to 2.8 degrees is wnl)

Large angle kappa may be caused by retinal traction as in ROP with temporal dragging of the macula
The Prism Cover Test: *important pearls to remember*...

Don’t block pt’s view with your head!
When measuring in lateral gazes, make sure pt can see fixation target with adducted eye!
Dissociate maximally – pt’s have strong compensatory innervation to keep their eyes align
Don’t hurry/repeat APCT a few times if needed
For diagnostic purposes, measure 25 to 30 degrees from primary position, you may not uncover a paresis or restriction if you don’t expand the binocular field to its outer limits.
Some examiners like to measure till there is a reversal of the redress, personal preference
Sometimes it’s difficult to be certain of the end point of neutralizing the turn because of a rebound saccade. Do your best estimation.
Positioning of the prism is very important – make certain to hold the prism straight, so you won’t induce a vertical if you’re measuring a purely horizontal deviation and vice versa for a vertical deviation.
Primary and Secondary Deviation – more likely to be seen with a new onset palsy, when monitoring the progression of the palsy from OV to OV, be consistent with your measurements.
Be aware of an Angle Kappa – things may not be what they look like!
Sometimes you can’t or it’s difficult to do APCT – you may need to do a Krimsky
Poor fixation in a blind eye
Nystagmus
Use of Prisms

Mitchell Strominger, MD
Use of prisms

Ground in or Fresnel press on prisms

Pearls:
Give the least amount of prism that will accomplish steady fusion – start with $\frac{1}{2}$ the measured amount in primary position and increase until steady fusion

Patients typically do not move their eye laterally more than 10 – 12 degrees

If bifocals, make sure that if no diplopia at distance that acceptable at near otherwise may need separate reading and distance glasses
Gound in prism:
Split the prism 50:50 unless marked incomitance, then may need to prescribe asymmetrically or put all on one side
Keep amount to 6 prism diopters or less
AR coating might decrease glare
Fresnel press on prism:
Inexpensive - $21.00
Temporary
Prism adaptation test
prior to surgery
prior to ground in
Fresnel press on prism:
Determine amount with loose prism distance – primary reading
Lines degrade vision place on non preferred eye
Can tilt for horizontal and vertical components
Fresnel press on prism
Place on inside of glass in correct orientation and trace size with a pen
Cut Fresnel and press on
Case presentations
36yo with Graves Dz
RAI
Levothyroxine
s/p Bilateral orbital decompressions
c/o constant horizontal & vertical diplopia
Diplopia not getting better
- OS  Limitation of abduction & supraduction
- OD  Mild limitations of abduction/supraduction/infraduction
Treatment of Thyroid Orbitopathy

Occlusion
Prisms
Fresnel vs ground in
Surgery
Occlusion Techniques

- Alternatives
  - Tape to lens
  - ‘Pirate Patch’
  - Min Lens
Occlusion Techniques

Bangerter Occlusion Filters/Foils
Varying strengths to blur diplopic image
Treatment

Large angle ET & Hypotropia
Incomitant deviation
Binocular Single Vision
Base Out 40 & Base Up 25° OS
Trial of Fresnels –
Unable to correct with 1 prism due to large deviation
need to split prism

Limitations
Aberrations / Blurred vision
Max 30°
Will only correct deviation in primary position – diplopia in other gaze positions
Surgery

Bilateral Medial Rectus Recessions
Left Inferior Rectus Recession

- Horizontal deviation eliminated
- Minimal vertical deviation
- Prisms more tolerable
- 6^ Base Up OS – Single vision

- Fresnel prism placed on plano lenses
Prisms

Incomitant deviation
Remind patients that they need to make head mvts not eye mvt when looking in different gaze positions

Large angle strabismus
Blurred vision >12°
Optical aberrations
Loss of contrast

Comitant deviations
Small-moderate angle strabismus

Cost of Fresnel is much lower than ground-in prism
Fresnel effective in temporary situations – cranial nerve IV, VI palsies

Careful selection of patients for prismatic correction, management of patient’s expectations and follow up to monitor the diplopia are critical to the successful use of prisms
Divergence Insufficiency

Shira Robbins, MD

Associate Professor of Ophthalmology Division of Pediatric Ophthalmology & Eye Alignment Disorders

University of California, San Diego
Case 1

This 60 year-old woman with 2 week hx constant binocular horizontal diplopia corresponding to cataract extraction left eye

D > N

Noted decreased left eye vision 3 years ago, left eye inturning x 18 mo no diplopia as vision so poor
PMHx/PSHx/Meds

SLE diag 1977
Retinal exams Q6 mo
Blood work Q3 mo
Head trauma as child
Facial surgery post trauma 10 years prior

2008 Cataract extraction + implant Right eye
2 weeks prior - Cataract extraction + implant Left eye

Plaquenil
Cortisone Injections
Paxil

ALLG - Sulfa
Exam

VA ➔ 20/25
➔ 20/80 ph 20/40 (mild myopia)

Color 8/8 OU
Pupils – APD, -anisocoria
SLE – Cornea clear centrally, AC D/Q, PCIOL OU good position
DFE – NI OU

Trigeminal fxn symm/nl
Near: ortho
BSV 12 ^BO
Divergence FA ↓ or Nl
Mechanism of Divergence Insuff
Deficit of a hypothetical divergence center in the central nervous system

Tight inelastic medial rectus muscles preventing effective abduction

Aging related lax/sagging lateral recti have been proposed as causative = ARDE (Age related Divergence Esotropia), Sagging Eye Syndrome
Take Away Points

Consider in cases of adult onset diplopia where no signs of CN6/INO exist, versions full.
Convergence Insufficiency

David B Granet, MD
Professor of Ophthalmology
Division of Pediatric Ophthalmology & Eye Alignment Disorders
University of California, San Diego
75yo with Parkinson’s s/p CEIOL OU c/o Intermittent horizontal diplopia when reading and when using the computer Patches OD when doing near activities
**Exam**

VA 20/25 OU
Near cc VA J2
EOM — full
SLE — wnl
DFE: wnl

**Prism Cover Test**
Distance: X4^ Near: add: X(T)'20

**NPC:** remote

**Convergence Fusional Amplitudes**
Distance:
Break 20^/Recover 16^ Near:
Unable — dissociated by prism
Treatment for CI

Orthoptic Exercises

Pencil Pushups
Stereograms
Computerized eye exercises (CVS program)
Base out Prisms to improve convergence amplitudes

Limitations – Parkinson’s Dz – physically unable to do exercises
Prisms for CI

Use Base In prisms to help with X(T) at near

How much BI prism to prescribe?
- Advise against correcting the full deviation at near
- Want the patient to use some of their convergence ability
- GOAL – enough BI prism to provide the patient with comfortable binocular single vision for near activities

Trial of Fresnel prisms on patient’s bifocals or reading/computer glasses
- Patient preferred 5^ Base In prism OD; 5^ Base In prism OS - bifocals
Fresnel
• Split prism glasses
  o No prism at distance
  o Base In prism at near
IVth Nerve Palsy

Shelley Klein, CO
Tufts Medical Center
Boston, MA
AY

53 yo gentleman
Mar 6 2002

4 year history of diplopia relieved by head tilt to the left
Presumed breakdown of a congenital 4th nerve palsy
Given glasses with 2 base down OD and 2 base up OS
Harder to control over past year
20/20 OU
6 RHT – 25 RHT – 40 RHT
4+ RIOOA, minimal depression deficit on adduction
April 5 2002 RIO recession

November 2003

Diplopia only when tilting head to the right

3 RH
December 22 2010 (8 years later), now 62 yo
Falling a lot with problems controlling diplopia
20/15 OU
5 to 10 degree head tilt to the left
-1.5 underaction of the RSO

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<th>PCT:</th>
<th>Ortho</th>
<th>3RH(T)</th>
<th>3RH(T)</th>
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<tbody>
<tr>
<td>14RHT</td>
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<td>builds to 25RHT</td>
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AY
AY: Fourth Nerve Schwannoma
• Referred for stereotactic radiosurgery of a presumed schwannoma

• 4/29/11
  - 13 Gy
  - 50% isodose line via a plan of 14 isocenter each of 4 mm collimation
Recurring diplopia complaints
Did not want further surgery
2 RH(T) – 8 RH(T) – 12RHT
Downgaze 16 RHT

Now what?
Prism glasses
How much should we give? Which eye?
Bifocal v separate full frame readers
VIth Nerve Palsy

Shelley Klein, CO
Tufts Medical Center
Boston, MA
KC: 47 yof followed for a Left VIth Nerve Palsy

April 2008 was 1\textsuperscript{st} seen by MBS, referred for progressive left head turn with ET requiring prism glasses. Diplopia worse in left gaze. No pain or discomfort.

POH:
Pt did not recall having a head turn as a child
Remembers 1\textsuperscript{st} observing diplopia late 20s, was given prism Rx
Was told at that time she had Duane’s Syndrome
Findings from initial exam:

AHP: Left head turn (can fuse with AHP)
Single Cover Test: D/N – LET in forced primary position
Fixation Preference: OD

DVA sc OD 20/20  OS 20/25
Stereopsis: 40 secs
Ductions: -4LLR, with no globe retraction on adduction
Forced Ductions: no significant restriction
Prism Cover Test: (Fix OD with prisms over OS)
  Distance:  3E ↔ 35LET 5LHypoT → 55LET 6LHypoT
  Near: 20LET’
Impression and Plan:
Almost complete Abduction deficit OS
Not typical Duane’s
no globe retraction on adduction
no constriction of LMR with forced ductions which one would expect with MR contracture of a longstanding ET
More suspicious of Left VI th NP
Mild anisometropic myopia OS
Ordered MRI
Proceed with treatment after results
MRI results: Thin LLR with a loop of the Basilar in the Left pre-pontine cistern most probably compressing the VIIth nerve
Plan: Proceed with strabismus surgery
July 2008: LSR and LIR - full tendon transfer to LLR with posterior fixation suture.

1 year PO visit: Recurring symptoms, ↑ left head turn

PCT: Distance 1E ← 25LET → 50LET/7LHypoT
Near 9E(T)’
Ductions: -3.5 LLR

Plan: More surgery
July 2009: LMR recession on adjustable with initial hangback of 6.0mm posterior to insertion with further 3.0mm recession on adjustment.

Noted to have a slight adduction deficit and continued significant abduction deficit with forced ductions at end of surgery.

5 month po visit:

Ductions: -1/2 LMR and -3.5 LLR

PCT: Dist 1X ← 12 E(T) → 50LET/4LHypoT

Near 4E’

Impression: Overall, stable alignment – generally asymptomatic

Plan: Fill anisometropic myopic Rx

1 year po visit: No significant change

3 year po visit: ET building to 20pd in primary position
4 year po visit: Recurring diplopia, ↑ left head turn

Ductions: -1/2 LMR, -4LLR, -1/2 LSR

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<th>20LET</th>
<th>&gt; 50LET</th>
<th>25LET</th>
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<td>14LET 2LHypoT</td>
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Near sc 10E(T)°
What now?

Consider more surgery – maybe on OD

Prism glasses

Can we improve head position?

Can we reduce diplopia?

• What to consider in prescribing prisms:
  - Creating an exotropia in Right gaze?
  - Convergence amplitudes in Right gaze?
  - ? Bifocal with “V” pattern ET
  - ? Better to have separate readers
  - How much prism can I give to really help?
To be discussed in our break out session.........
Diplopia Following Cataract Extraction

Mitchell Strominger, MD
Etiology of diplopia following cataract extraction

acquired extraocular muscle dysfunction

intraoperative injury

direct injury of muscle with retrobulbar needle

myotoxicity from the anesthesia or injected antibiotics

inferior rectus muscle more common

superior rectus muscle involvement can occur

restrictive component but can see overaction

decompensation of longstanding, preexisting strabismus

sensory strabismus (exotropia)

strabismus with suppression (divergence insufficiency)

switched fixation

systemic disorder with ocular involvement

thyroid orbitopathy

supranuclear palsy (Parkinsonism)
Figure 1. Cadaveric dissection of the orbit showing simulated retrobulbar injections with a 25-gauge, 1.5-inch needle. A, the needle penetrating the inferior rectus muscle is shown (arrow). B, the possibility of direct injury to the superior rectus muscle is confirmed (arrow) during a retrobulbar block; however, only the tip of the needle reaches the muscle.
Inferior oblique overaction
March 11th 2003

80 year old
Retired engineer
Referred for diplopia only when looking to the left
Immediately post Phaco PCIOL OD 11/11/02
Hx Phaco PCIOL OS 6/10/02
From the Desk of

H. J.

Date

L

R

...
## Measurements

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<th>1 RH</th>
<th>2 RH</th>
<th>3 RHT</th>
<th>4 RHT</th>
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Double maddox 2 degrees of excyclotorsion
Inferior oblique muscle injury from local anesthesia for cataract surgery

Four patients without preexisting strabismus who had diplopia following cataract surgery

Three had delayed onset hypertropia with fundus extorsion in the eye that underwent surgery

- Inferior oblique muscle overaction secondary to presumed contracture
- Inferior oblique recession in 2 cases
- Prisms in one case

One had immediate-onset hypotropia with fundus intorsion in the eye that underwent surgery

- Inferior oblique muscle paresis

Inferior Rectus Muscle Overaction After Cataract Extraction

two patients, peribulbar, OS, no bridle sutures

Case
15 degree excyclotropia

Case 2
4 degrees excyclotropia
myotoxicity, degeneration, regeneration, overaction

Munoz AJO 1994;118:664-666
Superior Rectus Muscle Overaction After Cataract Extraction

four patients, ipsilateral hypertropia worse in upgaze than downgaze transient postoperative weakness of ipsilateral inferior rectus contracture or strengthening of ipsilateral antagonist anesthetic myopathy or direct trauma to inferior rectus two patients recalled inability to look downward immediately post op

• Grimmett and Lambert AJO 1992;114:72-80
Case 1 – What's the diagnosis

68 year old complains of intermittent horizontal diplopia 3 months following cataract extraction in the left eye
Notices it more when driving and looking far away at road signs
Old glasses had to be re-ground a few times, since couldn't follow optoms specifications. Something about not being offset.

- 5.00 OD 20/20 / -2.00 OS 20/20
12 E(T) distance with poor control / ortho near
Case 2 – What’s the diagnosis

58 year old with horizontal diplopia following cataract extraction in the right eye

History of having worn glasses since age 4
Possible bifocals until high school
Remembers patching the left eye for years.
Vision therapy during elementary school

20/30 OD plano / 20/50 OS + 4.00
No stereo

4 ET distance and near with correction
3+ NS cataract left eye
Case 3 – What’s the diagnosis?

70 year old onset of lines bending in the road while driving only following removal of the cataract in the second eye

Remembers always having some double when looking to the left up until age 60, then improved. Never when looking straight ahead

Wife states that he always used to tilt his head when they first met and married, was getting worse for a while, but seems to have improved over the past 10 years.

20/20 OD -0.50 / 20/20 OS -0.50

Ortho – 10 RH(T) – 25 RHT

4+ right inferior oblique overaction
Case 4 – What’s the diagnosis

63 year old complains of horizontal diplopia following bilateral cataract extraction

Sometimes had to close the left eye when extremely tired or out in the sun

Always wore glasses for distance but would take them off to read

Now doesn’t need glasses for either distance or near to see clearly

Without correction 20/20 OD / 20/40 OS (Mrx OS-1.50 20/20)

18 LX(T) distance / 18 LX(T) near – poor control
Preexisting Strabismus

Beware of reversal of ocular dominance

Breakdown of strabismus secondary to reduced acuity and fusional instability from cataract

Suppression or ability to ignore second image because of cataract
Case 5 – What's the diagnosis

64 year old with higher double line when trying to read channel guide on TV (TV above fireplace), no double when reading. Has to hold chin up while driving.

Eyes seem puffy in the morning upon awakening

History of Radioactive Iodide treatment age 45

1 pack per day smoker

Synthroid

Mild elevation deficit of the right eye

12 Rhypo

4 Rhypo

ortho
Case 6 – What's the diagnosis

90 year old complains of the words running together while reading following bilateral cataract extraction.

Prior to surgery only needed reading glasses, but states that they were quite thick

Paid top dollar for premium multifocal IOL’s and the vision is “great” for both distance and near.

Vision 20/25 both eyes for distance and near

Doesn’t seem to blink that much and shuffled into exam room

Ortho - distance, 12 X(T) near with poor NPC
Undiagnosed Systemic Disorders

occlusive effect of cataract masks the ocular deviation
PSP / Parkinsonism
intraoperative tissue manipulation may aggravate an autoimmune or inflammatory condition
Thyroid orbitopathy