Beyond Diagnosis: The Rehabilitation of Ocular Motor Paresis/Palsy

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Objectives

- Define paresis/palsy
- Review evaluation of paresis/palsy
- Review current treatment strategies
- Explore rehabilitation strategies vs. compensatory strategies
- Case presentations

Palsy-CN dysfunction or paralysis

Paresis-full or partial CN palsy?

Hemiplegia/Hemiparesis-complete or partial weakness

-Traditional Treatment-

Eliminate Diplopia
Patch the Paretic Eye

What Occurs with Direct Occlusion?

- Eliminates gazes where binocular depth perception is present
- Decreases peripheral vision for equilibrium and balance
- Decreases opportunity for recovery of monocular and binocular vision
- KEY – use monocular patching only as needed for safety (fall risk, etc.)

What Else Might You Try?

- Visual Guidance
- Selective Occlusion vs. Full
- Fresnel or Ground Prism
- Visual Rehabilitation –
  - Versions and Vergence
- And then consider surgery if still needed

Can Treatment Help?

- OT states that it is needless!
- Sites an article that 85% partial recovery rate, 65% complete
- Previous studies 38-80% recover
- Thus 'no treatment' is needed and only compensation required to help the patient (patch diplopia). But…shift of egocenter? Balance?

Concerns of Interpretation

- 206 total, 108 used, 1 mo + 6mo FU
- Ignored other studies of 4278 & 1000
- Goal of study was to determine effect of treating systemic causes, does it help the paresis?
- Study states-"too small to generalize"
- *Based on alignment primary gaze only

Would a hemiplegic be cured if they could simply stand straight up?

Why would you test a palsy in primary gaze only?

(No versions or vergence)

OMD Texts on Paresis/Palsy

- Strabismus, heterophoria, ocular motor paralysis (Hugonnier) – treatment is OK for CN palsies
- Binocular vision and ocular motility (vonNoorden) – treatment is recommended case by case
- NO References found saying do not tx, research is minimal, but it makes sense to address visual concerns, ROF
- Real World-some OMD's downplay Tx

Next Question : When should one begin treatment?

Why Early Treatment?

- Definitive Diagnosis – what is the cause
- Look at ADL's, quality of life-how might this condition be involved?
- Ascertain possible treatment options
- Treating with "eye exercises" is a statement that does not consider the impact of vision on all aspects of life

What Should We Do ?

1-Support a discharge, nothing can be done visually.

2-Consider what he can and cannot do, what goals might we set ?

3-Determine what we might do to help him achieve those goals.

4-Work with OT/Speech/PT in carrying out the plan.

5-In this case, we began doll's eye with ocular motor activities afterward

Followup One Week Later

- Speech reports better visual attention to communication device (dynavox)
- Speech is last treatment of day, Speech reports he is no longer dozing off at end of day
- Overall better arousal and attention, no dozing off during my follow-up visit
- EOM – Typical 3-4 saccades during pursuit has reduced to 1 saccade, ROM and latency has also improved
- He is now EMERGING from his TBI! WHY?

Three Months Later

- Can move arms, hands and fingers, not walking, but uses standing table
- Now easily using his dynavox
- Making one word utterances
- Can track freely in space. Was provided EOM paresis protocol.
- Near lenses beneficial
- No longer in a bed…has become active

KEYS to Care

- EOM treatment is more than simply eye exercises, consider brain function!
- Subcortical drives cortical!
- By adding vestibular input and improving EOM control, the patient began to emerge from his TBI
- KEY-Effects of Visual-Vestibular Input upon rehabilitation as a whole

Treatment Considerations

- CURE IT? Or do we evaluate/manage?
- Promote recovery of EOM function – monoc/binoc, versions, vergence
- Prevention of contracture, atrophy
- Monocular patching eliminates diplopia, but it has MANY limitations to recovery
- KEY - Improve ADL's – ie-Rehab facility

Differential Diagnosis

- Paresis vs. Complete Palsy
- Subcortical vs. Cortical pathways
- Innervational Deficiencies
- Mechanical Restrictions
- Direct Muscle Trauma

Categories of Head Trauma Injury Affecting EOM Function

- Soft tissue injuries
- Orbital fractures
- Cranial neuropathies
- Intra-axial brain stem damage
- Cerebellar lesions
- Tumors
- Combinations

Special Considerations

- Effects upon EOM
  - Atrophy – paretic muscle
  - Contracture – opposing muscle
  - Muscle shortening – loss of cells
  - Vertical vs. Horizontal EOM
- Spread of commitance-how fresh ?
- Nerve regeneration
  - Speed
  - Aberrant

Testing for Paresis / Paralysis

- Monocular Range of Movement
  - Include Doll's Eye – repeated?
  - Document using Vision Disk
  - Include binocular ranges if possible
- CT in all 9 Positions of Gaze
- Underaction and Overaction
- Parks 3 Step – isolate cyclovertical EOM
- Hess-Lancaster testing

Version Testing

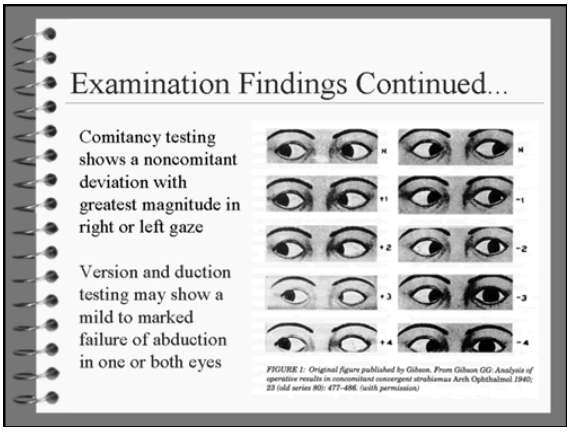
- Hering's Law of Equal Innervation
- Rate the movement on scale of 0-4
- Mark Overaction with +
- Mark Underaction with –
- Each number represents approximately a 25% change

Muscle Action Scale

GRADE		% Over/Underaction
0	=	Normal Action
1	=	25%
2	=	50%
3	=	75%
4	=	100%

*Look in 8 Positions of Gaze

*Consider Photodocumentation



Parks Three Step

- Which eye is hypertropic in primary gaze ?
- Hypertropia increases in which gaze ?
- Hypertropia increases with which head tilt ?

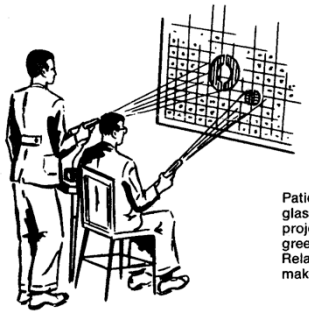
Considerations of Parks Three Step

- Isolates single cyclovertical muscle
- Problems
  - What if multiple muscles ?
  - Spreading of Comitance
    - Fresh vs. Old paretic cases
    - Paretic heals, antagonist has contracture
  - Doesn't differentiate paretic vs. fibrotic
  - Post-Operative findings may also be misleading

Spreading of Comitance

- A single cyclovertical EOM paresis may present later as different (RSO-LSR)
- May be considered as part of normal vergence adaptation. What leads to it?
- Prism adaptation – young vs. acquired
- Vertical aspects of anisometropia
- ABI patients have less resilience to overcome obstacles to performance

Hess Lancaster Testing



Patient wearing green and red glasses (provided) is given hand projector and directed to place green dot inside red circle. Relationship of dot to circle makes diagnosis possible.

Hess Lancaster Testing - RLR

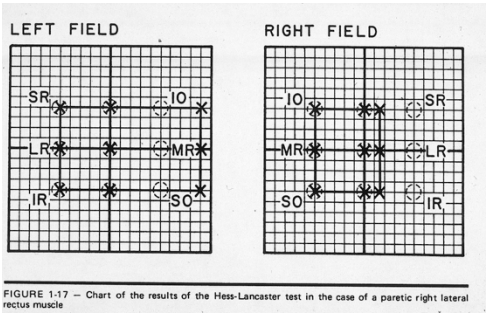


FIGURE 1-17 — Chart of the results of the Hess-Lancaster test in the case of a paretic right lateral rectus muscle

Hess Lancaster - RLR,RSO

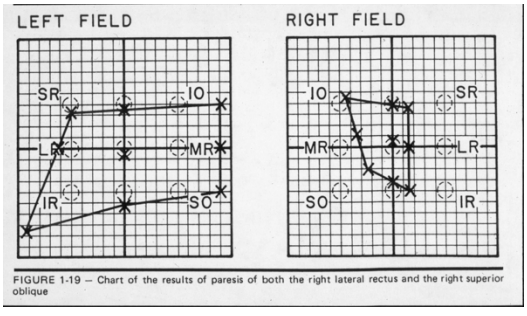


FIGURE 1-19 — Chart of the results of paresis of both the right lateral rectus and the right superior oblique

Special Considerations of Paresis and Palsy

- Patient needs -
  - Safety during mobility and ADL's
  - Recovery of function
- Patient, Rehab Team, OD goals
- Rehabilitation vs. Compensatory vs. Combined approaches

Traditional Treatment – Medical

- Monocular occlude – which one ?
- Wait and see
- Botox to decrease contracture
  - Sometimes aligns patient, why not tx ?
- Surgical considerations – 1 year

Another Look at the Medical View

- Why are EYES the only ones looked at from a "Wait and Hope" approach ?
- Benefits of unilateral full patching
  - No diplopia
- Side effects of unilateral full patching-
  - Decreased binocular input, child adapts
  - Possible shift in visual midline/egocenter
  - Decreased visual field
  - Muscle effects – contracture vs. atrophy
  - Effects upon functional recovery-ADL's

Overview for Treatment

- Visual Guidance
- Selective Occlusion
- Prism
- Visual rehabilitation
- Surgical consult
- Combinations – place and time considerations
- KEY – Monocular range of movement!

Optometric Considerations for Treatment

- Two Factors – balance the needs
- Range of Movement
- Diplopia Considerations
  - Occlusion – selective vs. full
  - Compensatory Prism
  - Guidance - Range of Diplopia
  - Underaction/Overaction

ROM Monocular Treatment

- 1-Pursuits
- 2-Saccades - Margolis Eye Throwing
- 3-OKN – www.BuyFabrics.com
- 4-VOR / Doll's Eye – Vestibular input
  - Single vs. repetitive inputs
  - Post rotary nystagmus – bidirectional
- Additional aspects
  - Monocular prism jumps
  - Afterimage transfer

S. Ron, et.al. Studies

- Can training be transferred from one oculomotor system to another?
  Physiological and Pathological aspects of Eye Movements. Roucoux & Crommelinck eds. 1982:83-98
- Eye Movements in Brain Damaged Patients
  Scand J Rehab Med 10:39-44,1978.

S. Ron, et.al., continued

- Plastic Changes in Eye Movements of Patients with Traumatic Brain Injury
  Progress in Oculomotor Research
  Fuchs & Becker eds. 233-240:1978
- Training Oculomotor Tracking
  Israel J of Medical Sciences 28:622-628, 1992

Oculomotor Therapy Effects in Traumatic Brain Injured Patients

	Faster Rate of Improvement
Saccades	4.5X
Optokinetic	3.0X
Pursuit	2.5X

*Higher level of improvement
*Some oculomotor subsystem transfer
See JBO article by Ciuffreda- EOM Rehab

Does improvement in EOM control mean it is also true for paresis / palsy cases ?

ABI Strabismus Overview

- Monocular – ROM, Selective Occlusion
- Biocular/MFBF – watch for suppression
- Binocular – KEY IS ROM!!!
  - Selective Occlusion
  - Prism – phasic and tonic aspects, visual and vestibular
  - Rehabilitation/Therapy – phasic and tonic aspects, visual, vestibular, motor
  - Vergence adaptation is important

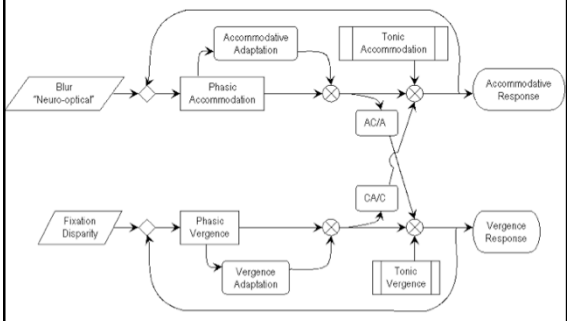
Vergence Adaptation

- How does one change the motor component?
- Surgeons believe only surgery can
- Jump Duction – William Ludlam,OD
- Vestibular Integration
- Consider effects of each of these upon tonic vergence (and EOM Proprioception)

Vergence Adaptation

- Tonic Vergence has phasic and tonic components
- Changes with accommodation
- Changes with repetitive vergence
- Central vs. peripheral viewing (size?)
- Vestibular – with motion processing
- Combinations?

Vision Rehabilitation / Therapy



Occlusion Considerations

- Compensatory vs. Therapeutic (both?)
- Size
- Unilateral vs. Bilateral
- Form – sector, spot, full, etc.
  - Nasal, Temporal, Superior, Inferior
  - Compensatory vs. Therapeutic
- Opaque vs. Graded vs. Color

Misassumptions of Binasals

- It straightens eyes (although it can !)
  - It is only a tool for changing visual behavior
- There is only one way to do it
  - It can be modified depending upon visual need
- It is done to the patient
  - The patients response is the critical component
- It works or it doesn't
  - Short vs. long term effects

Physiological Considerations of Binasal Width

- Basic Considerations of a Narrow Binasal
  - More emphasis on sensory, less proprioception
  - More binocular, less abduction required
- Basic Consideration of a Wider Binasal
  - More emphasis on proprioception, less sensory
  - Less binocular, more abduction required
- Basic Consideration of Asymmetry
  - Modifies sensory and motor aspects, "penalization"

The Binasal Continuum

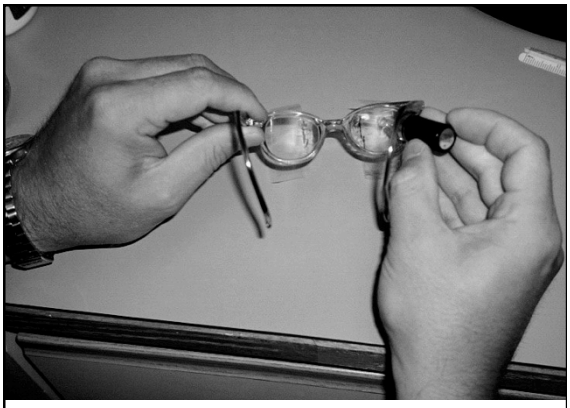
- Infantile Esotropia – Generally WIDER
  - More for recovery of abduction deficit
  - Promotes alternation and nasal to temporal motion
- Non-Accommodative Esotropia – MIDRANGE
  - Modify for alternation at midline
- Post Trauma Vision Syndrome – NARROWER
  - Decreases sensory confusion
  - Increases VEP amplitude

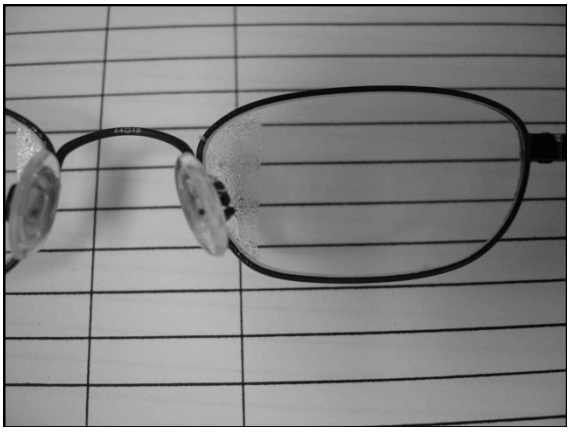
Occlusion – L CN6 Paresis

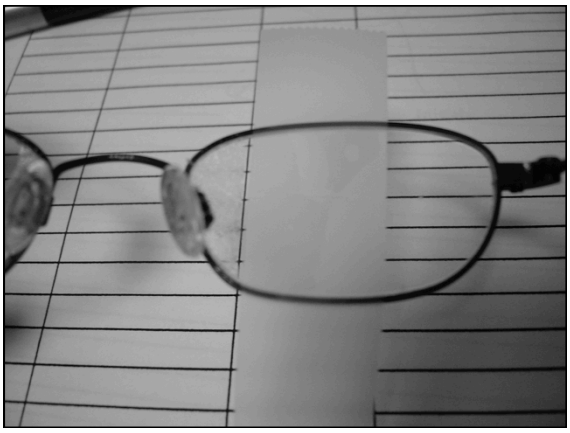
- Look L diplopia, R sees single
- Full Occlusion of L eye
- L Temporal Sector-OT
  - Eliminates diplopia to L
  - No therapy on L abduction
- ***R Nasal Sector-KEY!!!
  - Eliminates diplopia to L
  - Allows attempts to improve L abduction
  - Limitation of L gaze in mobility?

How to Apply Sector Occlusion

- Determine initial variables, modify as needed
- Streff Wedge – BC51 holder
- Application – nail polish or tape
- Recheck results, short vs. long term changes
- Readjust position as needed, decrease if stable
- *Be careful of anti-reflection coatings !







Placement of Binasal

- Related to condition and goals
  - Alignment, alternation, penalization, sensory/ motor
- KEY – while crossing midline, does fixation alternate (abducting eye should lead localization)
- Width and Location are Critical (sensory/ motor)
- Slant it or make it straight?
- Immediate vs. longer term changes
- Modify over time

Therapeutic Prism

- Goal is to establish single vision and to facilitate removal over time
  - If unable to remove all, compensatory !
- Monocular ranges – enough ?
- Is the binocular system established ?
- Tonic (slow) vs. Phasic (fast) Vergence and Vestibular systems
- No Fusion- Sensory Fusion Disruption Syndrome

Therapeutic Prism Protocol

- Use Fresnel prism, minimum to fuse
  - Changes in sensory, monocular vs. split
- Near vs. Far, Comitancy
- Weekly therapy vs. Periodic followup and modification of prism
- Every patient receives therapy including vestibular input
- GOAL-Reduce prism to zero, recheck fusional ranges, discharge, followup

Therapeutic Prism Protocol

- Therapeutic considerations-
  - Vestibular- may be key to modifying the Tonic Vergence System
- Vestibular activities
  - Turn and clap
  - Turn and catch
  - Bean Bag activities
- Supplement with traditional vergence therapy (Ludlam-jump duction)

Three Uses of Vestibular Ocular Reflex

- Maintain postural control, arousal/calm
- Kinetic/transitory contractions for maintenance of equilibrium and EOM during movement
- Maintain muscular tone (drive SC to C)
- Works with OKN to control blur
- Can be used in VISION REHAB
- *ALSO – vestibular input and arousal

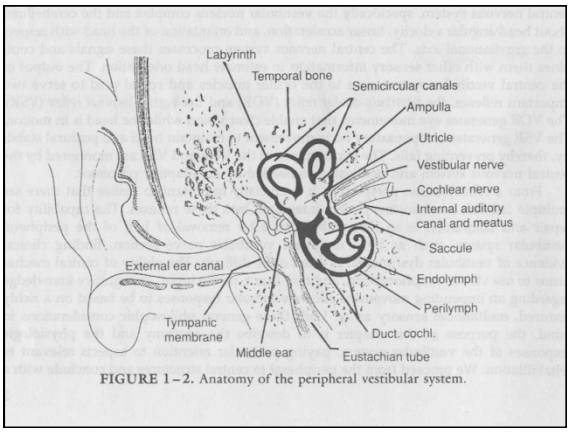
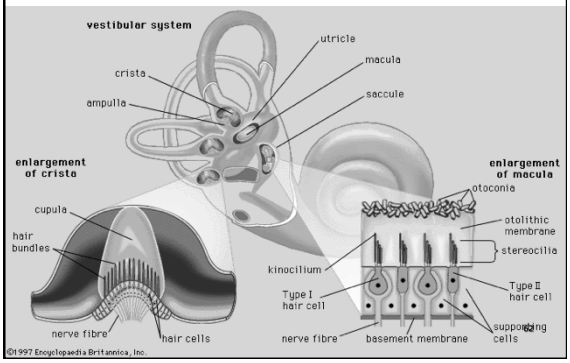
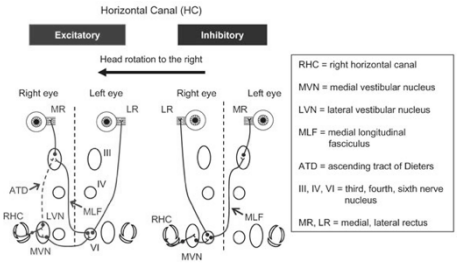


FIGURE 1–2. Anatomy of the peripheral vestibular system.

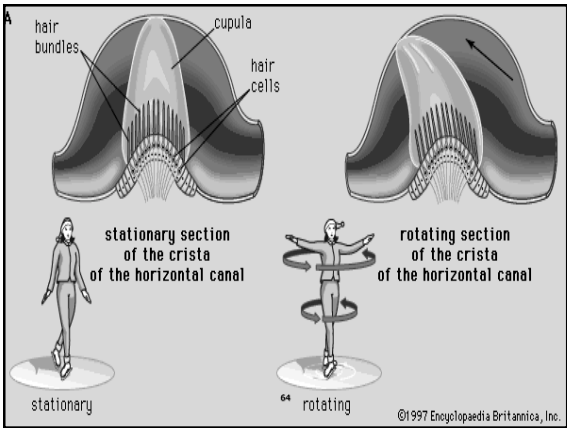
Vestibular Physiology



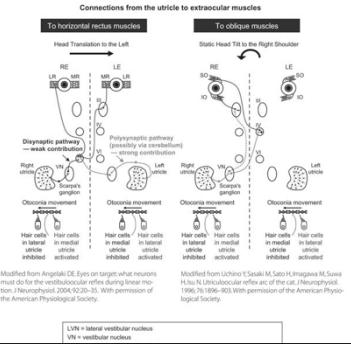
Bilateral Rotational Vestibular Input



Redrawn from Ito M, Nisimaru N, Yamamoto M. Pathways for the vestibulo-ocular reflex excitation arising from semicircular canals of rabbits. Exp Brain Res. 1976; 24:257–71. With permission of Springer Science and Business Media and the authors.



Bilateral Linear Vestibular Input



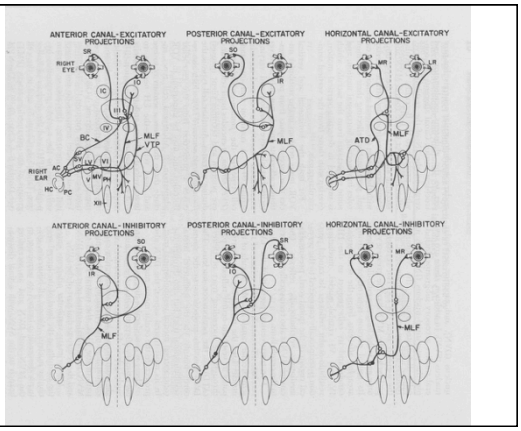
Modified from Angelaki DE. Eyes on target: what neurons must do for the vestibuloocular reflex during linear motion. J Neurophysiol. 2004; 92:20–35. With permission of the American Physiological Society.

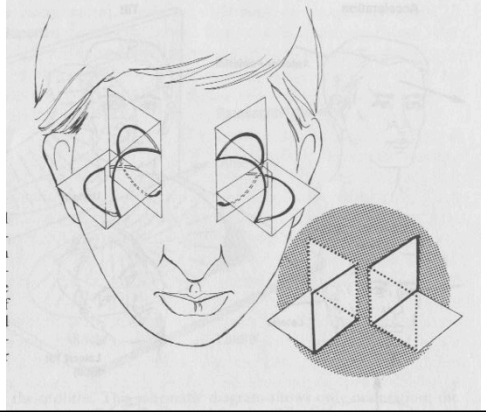
Modified from Uchino Y, Sasaki M, Sato H, Imagawa M, Suwa H, Isu N. Utriculoocular reflex arc of the cat. J Neurophysiol. 1996; 76:1896–903. With permission of the American Physiological Society.

Vestibular Component with Prism

- Semicircular Canals – Phasic Input
  - Each canal to specific muscle (pairs)
  - Rotational input
  - More likely used for esotropia
- Otoliths – Tonic Input
  - ALL EOM affected
  - Linear Input
  - More likely used for exotropia

BUT…combine both for overall outcomes ?





Pathways and Neurology

- Neural Integrator (NPH & INC)
  - Prolongs/shortens signal from peripheral apparatus
  - Signals from SCC/otoliths
  - Velocity signal to align eyes to speed of head rotation – This is cortical control
  - Nucleus Prepositus Hypoglossi - Horizontal control
  - Interstitial Nucleus of Cajal -Vertical and torsional control

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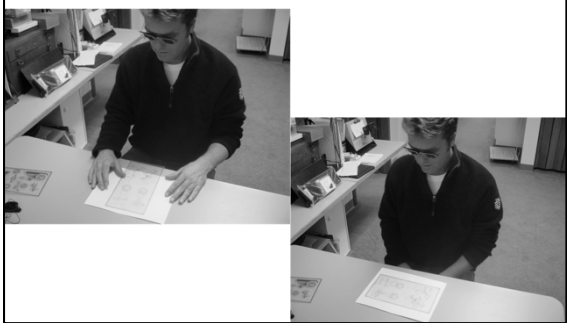
Bean Bag Toss – SCC

- 20X Head only, 20X Eyes only
- Increased arousal
- Increased alternation of bilateral input via vestibular, cervical
- Vestibular input modifies signal to the EOM via multiple pathways
- Result is often a reduction in tonic vergence – Horiz, Vertical, Cyclo
- Take pre and post phoria findings

Don't forget the fusional vergences – jump ductions!



Prism Considerations

- Benefits to increased peripheral field
- Benefits to visual midline and mobility
- Leads to treatment protocols for recovery vs. maladaptations
- *Learned recovery of diplopia
- Overall rehabilitation process is supported-vision leading and guiding.

Unilateral vs. Split Prism

- You can consider using a unilateral prism vs. separate horizontal and vertical prism in fresnel form
- http://64.50.176.246/tools/compounding.php
- Fresnel Prism also has a nomograph to calculate power

Overview for Treatment

- Visual Guidance
- Selective Occlusion – monoc ROM?
- Prism
- Visual rehabilitation
- Surgical consult
- Combinations

Case Presentations

F/U 2 Weeks

- Overall feels his life is back both from visual aspects and attention, fatigue, processing speed improved
- Reports diplopia in primary gaze was eliminated the next day
- Downgaze diplopia is infrequent, can fuse with blink
- These are the easy ones!!!

Summary Overview

- Start ASAP ! Never too early!
- Visual needs of the patient in rehab
- Recovery of Range of Movement
- Reestablish Binocularity
  - Selective Occlusion
  - Compensatory Prism
- Gaze palsies can also be treated
- Don't forget prevention/adaptations!

Visual Rehabilitation should be fuller and faster than the traditional unilateral patching regimen.