Neuro-Optometric Rehabilitation of the Acquired Brain Injury Patient
COPE Course ID: 42915-NO
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NCSOS Fall Congress
Asheville, NC
November 14, 2014

Presentation Objectives
• Review neurology of vision
• Review common visual dysfunctions associated with acquired brain injury
• Understand neuro-optometric care as part of multidisciplinary rehabilitation team
• Review techniques/instrumentation used to evaluate neuro-optometric patient
• Review treatments available

Video
Neuro-Optometric Rehabilitation
• Neuro-optometric rehabilitation growing subspecialty of optometry
• 2.5 million people sustained a TBI in 2010
• Stroke is a leading cause of death & a leading cause of long term disability in US
• Evidence of neuroplasticity

What is Neuro-Optometric Rehabilitation?
• Determining specific visual dysfunctions a patient is experiencing post ABI
• Designing an individualized treatment program to improve daily function and patient’s quality of life
• Rehabilitation of not only eyesight but entire vision process

Neuro-Optometric Rehabilitation
• Includes treatment for:
  ▫ Acquired strabismus
  ▫ Diplopia
  ▫ Binocular dysfunction
  ▫ Accommodative dysfunction
  ▫ Oculomotor dysfunction
  ▫ Visual spatial dysfunction
  ▫ Visual perceptual and cognitive deficits
  ▫ Traumatic visual acuity loss
Optometry’s Role

• Visual dysfunctions very common following ABI
• Often, referral for visual consult only occurs if diplopia, visual field deficit, injury to an eye or ocular pathology suspected

Optometry’s Role

Frequent problems not identified as being related to vision:
• Seeing objects appearing to move that are known to be stationary
• Reading difficulties not associated with blur
• Floor appears to be tilted
• Balance/coordination problems
• Dizziness
• Motion sickness
• Poor attention/concentration
• Inability to tolerate busy, crowded environments
• Poor spatial awareness

Optometry’s Role

• Many patients have negative CT scan/MRI even though suffer with multiple symptoms
• Vision evaluations often reveal 20/20 vision, healthy eyes
• Patient told symptoms, concerns, complaints “not in eyes”
• Symptoms may be dismissed as exaggerated & of psychosomatic origin
• Patient referred for psychological evaluation
• Accurate diagnosis/treatment can significantly improve rate of rehabilitation and enhance patient’s quality of life

Neuro-optometric Rehabilitation: History

• Late 1980’s vision rehabilitation limited
• Early 1990’s, new organization created called the Neuro-Optometric Rehabilitation Association (NORA)
• Doctors from across the country recognized ABI patients frequently had visual problems that were not being addressed through hospitals, rehabilitation centers or even private offices.

Neuro-optometric Rehabilitation Association (NORA)

• Founded to develop:
  ▫ Rehabilitation for patients with neurological dysfunction
  ▫ Education for doctors and professionals relating to approaches in visual rehabilitation
  ▫ Public awareness concerning what could be done through neuro-optometric rehabilitation to remediate visual dysfunctions

Neuro-optometric Rehabilitation Association (NORA)

• NORA has grown considerably over past 24 yrs
• 23rd annual NORA meeting was held this past April in Cary
• 24th annual meeting to be held in Denver, Colorado, May 14-17, 2015
• NORA was founded by optometrists, however, it is a multidisciplinary organization including occupational, physical, speech and vision therapists, educators, psychologists, chiropractors, and more.
• Website: www.nora.cc
Eyesight and Vision....
Is there a difference?

Eyesight is a measurement of sharpness of sight/a measurement of visual acuity.

Vision...

- our ability to derive meaning from what we see and then direct action

Vision is not synonymous with eyesight

“There is much more to vision than just pointing our eyes at the world and having the image projected onto an internal screen. Our brain has to make sense of the world, not simply reproduce it.”

Goodale and Milner, Sight Unseen

We see with our brains.
Vision

- There is no vision in the eye; it is a sensory organ only.
- The brain looks through the eyes.
- Retina is a piece of brain facing forward in a mobile container.
- Vision is the brain’s way of touching the world.

Traditional understanding of vision

The eye takes a picture and brain tells us what we see.

Vision

- There are nearly 2 million nerve fibers that exit the eyes.
- This represents approximately 70% of sensory nerve fibers in the entire body.
- Every lobe of the cerebral cortex is involved in the processing of visual information.
- Researchers have identified over 300 intra-cortical pathways linking 32 different cortical areas involved with vision function.
- 80% of all that we learn occurs through vision.

Visual Process is Complex....

Felleman and Van Essen 1991

Visual Pathway

Two separate feed-forward pathways

“What is it?” and “Where is it?”

Dorsal or “where” stream

Ventral or “what” stream

Spatial processing

Object processing

location

movement

spatial

transformations

spatial relations

color

texture

pictoral detail

shape

size
Cortical System

- Two separate but interacting feed-forward pathways
  Dorsal Stream
  Occipital Cortex → Middle Temporal Lobe → Posterior Parietal Lobe
  For motion detection and object localization
  "Where is it?" System

  Ventral Stream
  Occipital Cortex → Inferior Temporal Lobe
  For object identification
  "What is it?" System

Subcortical System

- Retina → Midbrain (Superior Colliculus) → Posterior parietal cortex
- Integration of visual information with tactile, proprioceptive and vestibular systems
- Spatial orientation system
- "Where Am I?" System

Cortical and Subcortical Systems

Let’s get clinical...

What would a vision problem look like with 20/20 acuity and normal ocular health?
**Binocularity Issues**

- Eye teaming dysfunctions common post ABI
- Most strab/diplopia cases referred because obvious
- Many are told to patch/wait 6 months
- There are also many non-strabismic binocular dysfunctions that do not get referred
  - 47-64% ABI patients diagnosed with vergence problems
- We point our eyes to where we think things are

**Oculomotor Dysfunction**

- Eye tracking difficulties common post ABI
  - Pursuit Dysfunction

**Visual Field Loss**

- **Unilateral** – retina/optic nerve
- **Bilateral** – chiasmal & post chiasmal
  - Homonymous
  - Quadrantanopsia
  - Congruous
  - Incongruous

**Unilateral Spatial Inattention**

(Previously known as Visual Neglect)

- Lack of awareness to visual space contralateral to lesion
- Most common left USI
  - Right parietal cortex (PC)
  - Left PC allocates attention to right field but right PC allocates attention to both fields
**USI: Characteristics**

- Personal space
  - Only shaves one side of face
- Peripersonal space
  - Misses food on one side of plate
- Extrapersonal space
  - Does not see an oncoming car when crossing the street

**Visual Midline Shift Syndrome**

- Mismatch between knowing where self is versus where objects are in relation to self
- Shifts direction of action
- Patients will veer to left/right when walking/driving

**Any neurological event can result in...**

- Disrupts communication between feed forward and feedback loops essential for directing action gracefully
- Causes an inefficient visual process
- Common clinical findings support a new syndrome......

**Post Trauma Vision Syndrome (PTVS)**

- **Common Characteristics**
  - Exotropia
  - Exophoria
  - Convergence Insufficiency
  - Accommodative Dysfunction
  - Oculomotor Dysfunction
  - Increased Myopia
  - Low Blink Rate
  - Spatial Disorientation

- **Common Symptoms**
  - Diplopia
  - Blurred Near Vision
  - Objects appear to move
  - Asthenopia/Headaches
  - Photophobia
  - Poor Concentration/Attn.
  - Poor Visual Memory
  - Staring Behavior
  - Motion Sickness
  - Difficulty with balance, coordination and posture

**CONCUSSION: Hot Topic**

AOA Guideline for TBI

What is a concussion?

- A complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces
  - Direct blow or impulsive forces transmitted to head
  - Typically results in rapid onset of neurological impairments
  - Functional, not structural injury
  - May or may not include LOC
  - Not identifiable on standard imaging (CT, MRI)

CNS Guidelines, 2009

MRI’s, CT Scans and other images tests

- Myth: “My child had an MRI and everything looked fine so they don’t have a concussion.”

- Truth:
  - Current imaging techniques used in most clinical settings are designed to identify structural abnormalities
  - Concussion is a functional abnormality and will return a negative finding on standard imaging techniques most of the time

Concussion: Loss of consciousness

- Myth: “I can’t have a concussion. I did not black out.”

- Truth:
  - 85%+ of diagnosed concussions result in no reported LOC

Concussion: How should I refer to the injury?

- Myth:
  - “I just had my bell rung. I don’t have a concussion.”

- Truth:
  - Concussions are injuries to the brain
  - “Bell ringers” or “dings” are mild forms of brain injury and should not be dismissed

Neurometabolic Cascade Following Injury

- What happens?
  - Massive release of excitatory neurotransmitters
  - Causes chemical imbalance, efflux of K⁺, influx of Ca²⁺
  - Increase in glucose metabolism
  - Occurs in a setting of diminished cerebral blood flow
  - Leads to energy crisis and...
  - Ultimately impaired axonal function
Signs/Symptoms of Concussion

- Confusion
- Disorientation
- Unsteadiness
- Dizziness
- Headache
- Visual disturbances

In Summary....

- Post ABI, many may spend years suffering from visual dysfunctions and PTVS unless diagnosed & treated properly
- Misdiagnosis can cause additional referral & treatment at high cost to families & third party
- Appropriate treatment will not only reduce symptoms but also prevent secondary emotional complications
- Dr. Mackowsky will discuss the methods of evaluation and treatment through neuro-optometric rehabilitation

What is Neuro-Optometric Vision Rehabilitation?

- “An individualized treatment regimen that rehabilitates the entire visual system; from the eye and surrounding structures to rehabilitation and management of sensory processing, integration of visual sensation with input from other senses, organization of sensory input into visual percepts and the use of these percepts to support cognitive function.”

Neuro-Optometric Rehabilitation

- Improve or eliminate symptoms caused by specific acquired vision dysfunctions.
- Treatment regimens encompass medically necessary lenses, tints and prisms with and without occlusion, and other appropriate medical rehabilitation strategies.
Neuro-Optometric Rehabilitation-Who needs it?

- Patients of all ages who have experienced neurological insults causing vision problems.
- Includes:
  - CVA
  - TBI (includes concussion)
  - Neuro-degenerative processes (MS, Parkinson’s, Alzheimer’s, etc.)
  - Cerebral palsy
  - Down’s syndrome
  - Autism
  - ADD/ADHD
  - Dyslexia

Unique vision issues in TBI population

Neuro-Developmental Optometry-Common Visual Dysfunctions

- PTVS
- Acquired strabismus
- CN/gaze palsies
- Binocular dysfunctions
- Accommodative dysfunctions
- Oculomotor dysfunctions
- Visual-spatial dysfunctions (VMSS)/balance issues
- Visual perceptual and cognitive deficits
- Traumatic visual acuity loss
- Visual field defects
- Unilateral spatial inattention

Common complaints reported by ABI patient and what you may see in your office

PTVS

- Possible diplopia
- Perceived movement of stationary objects
- Poor concentration/attention/easily distracted
- Photophobia/fluorescent lighting very bothersome
- Spatial Disorientation/clumsy/misjudges where objects are
- Dizzy

PTVS

- Blurred vision D/N (fluctuates)
- Poor night vision
- Eye discomfort/eyestrain
- Headaches/nausea after near work
- Feels “pulling” around the eyes
- Words move/run together while reading
- Skips or rereads lines
PTVS
- Distortion of side vision
- What looks straight ahead, isn’t always straight ahead
- Avoid crowds
- Very bothered by noisy environments

PTVS - Case Example
- 49 yo truck driver asleep in the cab of his truck, at a pull-off location. Another truck came from behind and rear ended him. Diagnosed with Post-Traumatic Vision Syndrome (PTVS).
- Video clip- asked to describe how his vision has been since the TBI.

PTVS
- Difficulty mobilizing shopping lanes
- Lack of confidence walking/missing steps/stumbling
- Poor balance/poor coordination

Video demonstrating how a TBI patient may walk into your exam room

33yo police woman with PTVS 2/2 an abduction during an arrest
**Binocular Anomalies**

- Closing one eye
- Head posture
  - Turning to the right or left—often with gaze to the opposite side
  - Chin up/down
- Blurred near vision due to deficient focusing
- Blurred distance vision due to myopic shifts with prescription

**Visual Field Defects and Visual Midline Shifts (VMSS)**

- Ambulation
  - Slower gait
  - Shorter stride
  - Uncertainty with movement
  - Veers to one side
- Weight is shifted to one side when standing/walking/seated

**Weight Distribution over BOS**

**Right HHFVD**

**Visual Field Defects**

- Reading
  - Reduced speed and accuracy
  - Omission of letters and numbers
  - Abbreviated scanning of lines
  - Transpositions, ie: now = won
  - Line skipping
  - Poor page navigation
- Writing
  - Drifting
  - Poor spacing

**Unilateral Spatial Inattention (USI)**

- Reduced balance and posture
- Leaning (forward, backward, right or left)
- Unable to initiate scanning to the involved side
- Unable to cross midline
- Overly turned to non-involved side
- Do not attend to involved side
Left mild/mod USI

Tools/tests utilized to evaluate the neuro-optometric patient

Case History
• Perhaps the most important of the examination
  ▫ Chief complaint
  ▫ HPI
  ▫ Referring physician
  ▫ Date of accident/injury
  ▫ Systemic and visual symptoms
  ▫ Medication list (very important)
  ▫ Personal/family history
  ▫ Current therapies/rehabilitation
  ▫ Nutritional Status
  ▫ What are the patient’s goals?

Observational Testing
• Fixation stability (is nystagmus present)
• Spatial localization
• Visual midline
• Visual attention
• Head turns and body position
• Gait

Ocular Flutter
• Horizontal saccadic oscillations without an intersaccadic interval
• Seen with central fixation
• Frequently encountered with cerebellar/brainstem disease
Neuro-optometric Sensorimotor Evaluation

- Visual acuities
- Pupils
- Color vision
- NPC- push in/red lens/"The Vergel"
- Cover test - all 9 positions of gaze
  - 92060- must include interpretation report
- Ocular motilities including ductions, pursuits, saccades, (any restrictions measure with vision disk)

Hirschberg Test

- Used to approximate the extent of deviation.
- A light is shone into the eyes, and its reflex on the cornea is assessed.
- Normally, the reflex should be slightly nasal to the center of the pupil.
- The accepted conversion is 1 mm of displacement equals 22 prism diopters of deviation.

Ocular Muscle Actions

- Broken arrows represent lost function; solid arrows represent tone in unaffected muscles. Compensatory head adjustments frequently are seen with loss of IV and VI.

Measuring Ductions w/ Vision Disk
Saccadic Tracking Example

Accommodative and Vergence Skills (including fusion)
- Accommodative amplitude
- MEM/FCC
- NRA/PRA
- Accommodative facility
- Phorias (with a prism bar)
- Vergences
- Fusional facility
- Worth 4 dot
- Random dot stereopsis
- M&S Technologies distance stereopsis

Refractive Considerations
- Refractive error by retinoscopy
- Aniseikonia
- Reading requirements/computer tasks
- Quality of responses
- Spatial elements
- Prism probing

Field of Vision
- Confrontation fields (finger count and simultaneous stimulation)
- Vision disk
- Amsler Grid
- Perimetry (Tangent screen/Automated)
- OKN

Field of Vision: OKN Testing
- Rotate drum to the right and look for nystagmoid movement left.
- Rotate drum to the left and look for nystagmoid movement right.
- A patient with a HHVFD will have a diminished nystagmoid movement when the drum is rotated away from the VFD.

Poor Man’s OKN
Spatial Inattention

- Observation
- Line bisection
- Star cancellation
- House/clock drawing
Sample House/Clock Drawing LUSI

Eye Health Evaluation
  • External ocular health
    ▫ Dry eye very common
    ▫ Rule out pathologies
  • Internal ocular health
    ▫ Optic nerve evaluation
      ▪ Atrophy
    ▫ Retina evaluation
      ▪ Tears, holes, detachments, degenerations

Perceptual Testing
  • MVPT- age normed 4-95
    ▪ Great screening tool
  • TVPS
  • VMI

Neuro-Sensory Testing
  • NOVA VEP (used to diagnose PTVS)
  • Platform posturography (used to diagnose balance disorders)
  • ENG (electroystagmogram measures normal eye movement and involuntary rapid eye movements)
  • VAT (vestibular adaptation testing)
  • OAE (oto-acoustic emissions- used to diagnose hyperacusis secondary to HSV1 inflammation of outer hair cells of inner ear (as high as 65-80% in TBI population))
  • Visagraph

NOVA VEP

NOVA VEP
Visagraph

- An infrared tracking/recording device that measures eye movements.
- Allows one to assess reading fluency efficiency, prescribe and evaluate corrective reading fluency training and detect visual/functional difficulties.

The patient is asked to wear special goggles that have the sensors which track the eye movements during reading.

Passive Treatment

- Lens and prism corrections
  - Corrective vs compensatory
  - CN palsies and muscle imbalances
- Therapeutic prisms
  - To enhance and stimulate visual spatial skills in order to affect the ambient processing
  - PTVS and VMSS
- Occlusion

Lens Strategy

- Lenses
  - Strabismus (Accommodative Esotropia)
  - Accommodative Dysfunctions
  - Performed in free-space (trial frame)
  - Evaluate sitting/standing

Treatment

Passive vs Active
Prism Strategy

- Correcting
  - Realignment of the visual axes to:
    - Eliminate diplopia/stimulate cortical fusion
    - Reduce anomalous adaptations
    - Suppression
    - Anomalous eye–hand relationships
    - Head turns and tilts

Types of Prism

- Fresnel Prisms (put on non-dominant eye)
  - Elimination of diplopia allows patient to concentrate upon other aspects of rehab and recovery
  - Inexpensive but must be exacting
  - Limitations of clarity in higher powers and alterations in spatial awareness
- Ground-in Prisms

Fresnel Prism

- Yoked Prisms
  - VMLS/PTVS
- Spotting Prisms
  - VFD

Prism Strategy

- Yoked Prisms
  - VMLS/PTVS
  - Spotting Prisms
    - VFD

Yoked Prisms

- Reorganizes the relationship between the ambient/spatial process and motor/proprrioception to counter the effects of VMLS.
- Prescribed in conjunction with PT/OT/Neuro-optometric programs causing rehab potentials to be maximized.
  - Custom ground design to incorporate the patient’s individual prescriptive needs
  - Rotatable form

Yoked Prism Example
Visual Field Awareness System

- Used for spotting, locating, and identifying into the area of visual loss
- Enhanced indoor and outdoor mobility, increasing safety and reducing likelihood of repeated, secondary trauma
- Improves functioning with everyday tasks (i.e., walking, cooking, working, sports, and in some cases, driving)

Peli System

- Increased field of view
- Peripheral diplopia
- Clear single central vision

Occlusion Strategy

- Alternate vs Constant
- Partial vs Total
  - Spot Occlusion
  - 3M Pore
  - Binasal Occlusion
- Opaque vs Translucent

Binocular Aspects of Binasal Occlusion (BINO)

- Increases monocular vs. binocular overlap
  - Decreases “noise” for unstable binocular processing
- Abducting eye leads localization
  - Eliminate cross fixation

Top image: Both eyes are processing their full extent of monocular visual field. The darker, middle hatched area represents the binocular visual field, where the 2 monocular visual fields overlap.

Bottom image: BINO decreases the monocular visual field area of each eye. This reduces the percent of the visual field that is processed binocularly without reducing the overall extent of the visual field. When there is difficulty coordinating information received from the 2 eyes, BINO alleviates the visual processing demands.
Active Treatment

• Neuro-visual rehabilitation therapy
  ▫ Different strategies utilized in the therapy room to enhance the patient’s ambient processing, center visual midline so that now there is a good “base of support” for now training one’s visual efficiency/perceptual abilities.
• Care Coordination with other healthcare practitioners
  ▫ PT, OT, Speech, Physiatrist, Neurology, Neuropsychology, social work or other allied medical practitioners.

Fact or Fallacy #1

• The vision system and vestibular system are linked together.

FACT

Recommended Book

Eye Movement DISORDERS

New Buzz Words

Neural Plasticity
Case Example: BC 25yo WM

- As a child had OS esotropia
- Surgically corrected at 6 years old
- Was aligned for a while but then eye started to turn out when he was 12
- Notices poor depth perception
- Read the book “Fixing My Gaze by Dr. Susan Barry” decided he wanted to do something about it.

Clinical Findings

- Current prescription
  - OD: +1.00 20/20
  - OS: +2.00 -.50 x 110 20/25

Clinical Findings

- Stereopsis: alternating suppression
- Cover Test: Constant alternating 35 pd Exotropia at distance and near
- Normal Oculomotor skills
- Worth 4 dot: OS suppression
- Manifest Refraction:
  - OD: +.75 -.75 x 100
  - OS: +1.50-1.25 x 100

Treatment Recommendations

- New therapeutic RX:
  - Manifest with 2 pd base down
  - Vision Rehabilitation-20 sessions

Post-Therapy

- Went from Constant left exotropia to Exophoria- in other words his eyes were now straight
- Was able to fuse peripheral fusional targets
- NPC to the nose
- Worth 4 dot: Normal
Fact or Fallacy #3

- Home therapy or computer orthoptics is as effective as office-based vision therapy.

**FALLACY**

Therapy Performed

- **Group 1:** Children in this group came to the office once per week for a 60-minute therapy session with a trained therapist. During these sessions, the children worked on 4-6 procedures designed to improve the ability to converge the eyes. The children in this group also did home therapy for 15 minutes, 5 days per week to practice the procedures learned during the office visits.
- **Group 2:** The child had to follow a small letter on a pencil as the pencil was moved toward the bridge of his nose. His goal was to keep the letter clear and single, but to stop if the letter became double. The child was told to try and get the pencil closer and closer to the bridge of his nose each day. This was practiced for 15 minutes, 5 days per week.
- **Group 3:** The child was given complex exercises using a computer program plus pencil push-ups.
- **Group 4:** This group was given placebo vision activities designed to simulate office-based therapy.

Convergence Insufficiency Treatment Trial (CITT)

- Gold Standard Randomized Clinical Trial
- Performed at 9 clinical centers
- Results Compared for: decreasing symptoms and improving the physical measurements of the convergence problem.
- 4 Groups
  - Office Based Vision Therapy with a trained Vision Therapist along with home reinforcement
  - Home-based pencil push-up therapy
  - Home-based computer vision therapy and pencil push-up therapy
  - Office-based Placebo therapy

Study Results

- 75 percent of those who received in-office therapy by a trained therapist plus at-home treatment reported fewer and less severe symptoms related to reading and other near work. Symptoms of CI included loss of place, loss of concentration, reading slowly, eyestrain, headaches, blurry vision, and double vision.
- Pencil Push-up therapy and computer therapy or the combination of both was **NO MORE EFFECTIVE** than the placebo therapy

More Information

- **College of Optometrists in Vision Development:** [www.covd.org](http://www.covd.org)
- **Neuro-Optometric Rehabilitation Association:** [www.nora.cc](http://www.nora.cc)
- **convergenceinsufficiency.net**
- **Visionhelp Blog:** [http://visionhelp.wordpress.com](http://visionhelp.wordpress.com)
- **My website:** [www.drmackowsky.com](http://www.drmackowsky.com)

Recommended Books
References

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THANK YOU!!