DISCLOSURES

I have no disclosures, financial or otherwise.

WHAT IS TRAUMATIC BRAIN INJURY?

• Traumatic Brain Injury or TBI, as explained by the Centers for Disease Control and Prevention (CDC) is “an injury that affects how the brain works and can be caused by a bump, blow, jolt to the head or penetrating injury.”
• They further classify three types of Traumatic Brain Injuries – Mild, Moderate and Severe
• Concussion refers to the quick acceleration and deceleration of the brain which can damage or stretch cells, neurons and blood vessels, resulting in change of membrane permeability

TBI – MILD, MODERATE AND SEVERE

• For mild TBI (mTBI), it can also come as a result of a hit to the rest of the body causing the head, and in turn the brain to move forwards (coup) and back rapidly (contrecoup)
• Moderate and severe TBI are constituted by direct injuries to the head
• This is different than Acquired Brain Injury (ABI) which are not a result of trauma, such as a stroke or brain tumor

PREVALENCE OF TBI

• TBI sustained from road traffic injuries alone are approximately to occur to 69 million people worldwide on a yearly basis
• The incidence rate of TBI per 100,000 people was greater in North America, than anywhere else!
• TBI most often occurs due to falls, motor vehicle accidents, assaults and firearm related injury in the United States
• TBI has a greater prevalence among males than females, however females typically had a higher severity of injury and likelihood of death

TBI INCIDENCE DISTRIBUTION

Data taken from 2010 study from the National Institute of Mental Health and Neurosciences Centre in India

PHYSIOLOGICAL/ANATOMICAL EFFECTS

• Dependent on the severity and location of the injury.
  
  Primary injuries are the result of the direct force of trauma, whereas secondary injuries are the indirect aftereffects such as edema, increased intracranial pressure, loss of oxygen or infection.
  
  Injury lesions can be focal or diffuse (or a combination).
  
  Focal largely affect one area, such as contusions and hematomas, whereas diffuse typically are spread out anatomically, such as axonal, ischemic and microvascular injury.
  
  Several factors contribute to the aftereffects of brain injury, including hormone levels which can have neuroprotective effects (progesterone and estrogen).

VISUAL SYMPTOMS

• Visual Fatigue
  
  • Eyestrain
  
  • Blurry Vision
  
  • Diplopia
  
  • Skipping or repeating words/lines of print
  
  • Words running together

SYSTEMIC SYMPTOMS

• Head and Neck Pain
  
  • Fatigue/weakness
  
  • Nausea
  
  • Vertigo
  
  • Difficulty/Poor Sleeping
  
  • Jaw Clenching
  
  • Tinnitus
  
  • Brain Fog
  
  • Supermarket Syndrome

COORDINATION OF CARE

Essential to the overall wellbeing of the patient.

• Professionals who may be involved:
  
  • Neurologists
  
  • GP/PCP
  
  • Disability Care Worker
  
  • Dentist
  
  • Chiropractor
  
  • Vestibular Therapist
  
  • Physical Therapist
  
  • Occupational Therapist
  
  • Speech Therapist
  
  • Sports Injury Therapist
  
  • Psychologist
  
  • Dentist
  
  • Many others!

ASSESSMENT TOOLS

Patient history:

• Can help identify key symptoms, background, history of injury, overall medical history.

• Can help identify signs and symptoms, and get more details as necessary.

• Knowing context of injury can help determine other existing medical issues, necessary referrals, any aspects of the body are adversely affected.
OCULOMOTOR SYSTEM

Pursuits – With and Without Loading
Saccades – Wolff Wands
DHM
Retinal symptom history

ACCOMMODATIVE SYSTEM

NRA
PRA
Calculate Minimum Expected Amps
Monocular Accommodative Amplitudes
AC/A Ratio
Recommending Facilities with +/-2.00

BINOCULAR SYSTEM

Memory Testing
Near Point of Convergence and Near
Near Point of Convergence and Near
Near Range of Comfort
Distant Testing Distance and Near
Distant Testing Distance and Near

ASSESSMENT AND REASSESSMENT

• Comparison of data between first and second assessment
• Consider re-checking every 9-10 sessions
• Rating symptoms on scale of 1-10
• Encourage frequent blinks and resting eyes in between tests

VISION THERAPY: CENTRAL- PERIPHERAL

CPR
Walking Bull
Touch and Go
Headwrist High Screw
Chalkboard Order
Lose Letterbox Left
VISION THERAPY: OCULOMOTOR
- Column Jumping
- Hart Chart
- Pegboard Rotator
- Eye Control
- Colour Jumps
- Bat a Vis It

VISION THERAPY: ACCOMMODATIVE
- Near/Far Bullseye
- Near/Far Hart Chart
- Monocular/Binocular Accommodative Rock
- Task Pad Refraction Lens
- Ocular Awareness
- Near Hijump Jockey

VISION THERAPY: BINOCULARITY/ VERGENCE
- Pointer Straw
- Straw and Error!
- Tranaglyphs
- Overlapping Pictures
- Word Revers
- Aperture Rule
- Split Pupil
- Bifocal
- Bifocal Awareness
- Near Far Jump Ductions

VISION THERAPY ADAPTATIONS AND ABSTRACT SYMPTOMS: MEMORY/AUDITORY/PERCEPTUAL
- Morse Code
- Snap Tap
- Silent 7
- Rapid Automatic Naming Vis Nu Go
- HTS – Tachistoscope
- Multimatrix Columns

ADJUNCTIVE TREATMENTS
- Binasals – Trial and Error!
- Adding Cognitive Loading
- Adding Metronome
- Adding Motor Movement
- Adding Distracting Sounds – Spotify playlist
- Rapid Automatic Naming/Go–No Go

CASE EXAMPLES
- Blue, Pink, Grey and Brown
- Very useful for photosensitivity patients
CASE A – 41 YR OLD FEMALE: C.R.

**Presenting History**
- Physical therapist who was hit by a car in April 2020. She was smoked for 3 months and then started working. She took a week off in June 2021.
- Dizziness and nausea decreased by 20% after 3 weeks.
- Headaches and fatigue decreased by 50%.
- Seizures completed this date, will return for a review session and may return later for movement.

**Therapy Progress**
- It is working gradually increasing working hours. A few weeks, unable to taste food.
- Tinnitus resolved with use of a smartphone.
- Improved vision and gait.
- Decreased nausea and headaches.
- Increased appetite and mobility.
- Improved balance and cognition.
- Increased range of motion.
- Improved standing balance.
- Increased arm and leg range.

CASE B – 36 YR OLD MALE: JC

**Presenting History**
- JC is a massage therapist, history of a motor vehicle accident in 2015, for which he received medical and cognitive behavioral therapy, followed by another brain injury in 2020, which had a similar effect on his vision.
- Seizures: Completed 5 to date, needs weekend to recover after each session, every monthly.
- Testing notes: Extremely symptomatic
- ODM - Flushing, dizziness, sweating, shaving of words.
- Phonoper testing: Seizures, disintegration to close eyes.
- Occasional (30%) - on DSM, when shown 2-20 for accommodation of text.

**Therapy Progress**
- Being aware of triggers: Red/Green, near stimuli, excess motion.
- No longer on medication when objects come within 40 cm of his face; still need to work within 15-20 cm.
- Could not stand and switch between two columns with eyes closed, now able to read 1 column.
- Can see whole chart while standing.
- Better at reading/hearing for exercises.
- No longer on light sensitivity as when starting therapy.
- Feels more emotionally stable than before starting therapy.
- Long road ahead but motivated to continue based on current progress.

CASE C – 51 YR OLD FEMALE: LC

**Presenting History**
- LC is a social worker who left while studying Dec 2020 and lost his bias. CT scan showed fluid in the right temporal lobe and diagnosis with severe concussion.
- Session completed 10 to date, written weekly for 6 weeks.
- Malnutrition: Trouble with reading, computer work, words missing on page, severe brain fog.
- Headaches, cognitive, depression, neurobehavioral syndromes.
- Cognitive impairment.
- Session Notes/Observations:
  - Increased fatigue and irritability.
  - Improved mood and alertness.
  - Cognitive improvement: memory for faces.
  - Reduced symptoms: anxiety, depression, and irritability.

**Therapy Progress**
- After 9 sessions - Re-assessment:
  - DVA: All subjective went from 80% to 100%, and perceived levels of anxiety went from below the 24 percentile to above 100 percentile.
  - MCI: Increased from 1.5 to 10.0.
  - OCM: Improved from 1.5 to 10.0.
  - Headaches similar to levels before concussion, worse no longer related to work.
  - Mood: Improved from 1 through 4 to 5 through 7.
  - Memory: Improved from 1 through 4 to 5 through 6.
  - Attention: Improved from 1 through 4 to 5 through 6.
  - Movement: Improved from 1 through 4 to 5 through 6.
  - Movement: Improved from 1 through 4 to 5 through 6.
- Ocular: Improved vision, decreased strain, decreased glare.

ADAPTATIONS
- Masks in place!
- Rest breaks
- Breaking activities into smaller chunks or doing half
- Remaining Seated for activities
- Dimming lighting in the room

IMPACT OF COVID
- Covid has had an impact on everyone, one way or another. It also has effects on our interactions with patients.
- Some may not be as comfortable coming to in-person sessions, doing them via Zoom has also been an option. This does place certain limitations for developing relationships and observing their detailed reactions to different exercises.
- It also increases their screen usage which is often a trigger for them, and may lead to quicker fatigue.
- Underlying mental health difficulties may also be more prominent as exacerbated by both their anxiety and stress levels.

FUTURE OUTLOOK
- This area of vision therapy is continuing to grow and become more widely acknowledged.
- With the high rates of traumatic brain injury and the long-lasting side-effects, it is crucial that we inform others of the impact it has and provide access to care.
- By coordinating with other members of the healthcare team, sending updates to those practitioners and getting involved in the traumatic brain injury community, we can gain better understanding and help others do the same.
CR: I'm much better now than I was six months ago. This gave me the ability to keep working and get off disability.

"JC: I've already started to notice improvements, things I never would have been able to do when we first started, I can do now."

"LC: I can comfortably use a computer for just over an hour now. When I first started, I couldn't go over 10 minutes without feeling uncomfortable."

LIMITATIONS

- Limited overall or with Covid
- May have stopped working due to injury
- Necessary Referrals
- Exhaustion/Burnout
- Distance to travel
- Available driver – often family/spouse

FUTURE RESEARCH

- Microprism – Assess need and best use
- Cause/prevention of negative injury in seen with much of the TBI population
- Safety/practice assessment for children vs. adult with TBI

BIBLIOGRAPHY

THE VESTIBULAR SYSTEM: AN IMPORTANT TOOL IN OPTOMETRIC VISION REHABILITATION THERAPY

DISCLOSURES

I have no relevant financial relationships to disclose.

COURSE DESCRIPTION

• This presentation highlights a case study that shows how the vestibular system can be used in optometric vision rehabilitation therapy to help guide the eyes to achieve better alignment.

• Learning Objectives
  • By the end of this lecture:
    1. Attendees will have reviewed the vestibulo-ocular pathway.
    2. Attendees will be shown how the vestibular system can be used to aid a patient's eye alignment.
    3. Attendees will be able to apply what is learned to their own patient care.

THE VESTIBULAR SYSTEM

• The utricle and saccule provides linear acceleration information.
• The semicircular canals provide angular acceleration information.
  • Oriented in 3 different planes.
  • These canals are in the same planes as the actions of the EOMs

THE VESTIBULO-OCULAR REFLEX

• The vestibulo-ocular reflex helps keep us steady by stabilizing our retinal image by keeping the eye still despite head movement and motion.
• The eyes move at the exact same speed but opposite direction of head movement.
• Horizontal VOR
  • Vestibular information enters the brain stem via CN VIII and enters the vestibular nuclei.
  • Signal is then sent through CN VI nucleus
  • One pathway heads to the lateral rectus via the abducens nerve
  • Another pathway heads to the medial rectus via the medial longitudinal fasciculus

THE VESTIBULO-OCULAR PATHWAY

• Rotational VOR
• Translational VOR
CASE H.Y.

- 60-year-old Caucasian female presents into clinic for a vision rehabilitation therapy evaluation post strabismus surgery. She reports persistent intermittent diplopia that causes her to feel uncomfortable while driving. She is currently using a 2BO Fresnel Prism over OD from surgeon. She wants to know if vision rehabilitation therapy can reduce her reliance on prism and increase the stability of her eyes.

Ocular history
- Strabismus surgery in December 2019
- History of previous vision therapy prior to strabismus surgery.
- Brain hemorrhage in December 2018 involving pons, occipital and parietal lobes
- LASIK OU 2004

INITIAL VISIT THERAPY AT INITIAL VISIT

THERAPY AT INITIAL VISIT

- Case stabilization
  - Patient instructed to move head horizontally and vertically while keeping fixation at a target that is approximately same distance away. Starting activity monocularly and slowly moving binocularly over time. Activity given for home therapy.
- CVST Test (BESTs)
  - Patient instructed to perform saccades with chart. Patient reports OD suppression starting at 2ft. Discusses anti-suppression techniques. Continue for home therapy slowly moving further from chart.
- Bean Bag Toss
  - Patient instructed to toss bean bag between her left and right hands in an arch. Perform saccades with head and eyes following bean bag then 20x eyes following while keeping head still. Activity given for home therapy.
- Reach String
  - Patient had difficulty appreciating physiological diplopia and would lose suppression of corpus. Activity discontinued at the time.

FIRST FOLLOW UP VISIT (12/22/20)

- Symptoms Update:
  - Patient reports an improvement in distance vision since her last visit. She reports that she does not need to use the 2pd BO Fresnel Prism most of the time and has clearer vision without using it. She still reports some difficulty driving very much due to poor weather.
- VA OD: 20/30 w/ 2pd BO Fresnel
- VA OS: 20/25
- EOMs:
  - Full with no restrictions, possible mild OS cyclotorsion
- Pupils: PERK (-) APD
- Confrontation VP: FFPC OD/OS
- Cover test av.
  - 3° HET (~70% of the time)
  - 0-4 esophoria
- Worth 4 dot: eso diplopia starting at 90cm
  - Worth 4 dot: eso diplopia starting at 45cm and further
- NPC: 9/10cm
- Pupils: jery and sustained
- Saccades: fast, mild under and overshoots
- Stereo: 3/3 Lang II
- Worth 4 dot: eso diplopia starting at 90
- Modified thorington: 4 eso posture

WHAT DETERMINES EOM TONE?

- Anatomical Factors:
  - Orientation, size, and shape of orbits
  - Volume viscosity of the retrobulbar tissue
  - Muscle insertion, length, elasticity, and structure
  - Arrangements of fasciae, ligaments, and pulleys of the orbit

- Innervational Factors:
  - Fixation reflex and fusional impulses
  - Influences of the static apparatus on EOMs and their tonus
  - Endolymph
  - Vestibular system
  - Reactions from neck muscles
  - Influences of the several nuclear and supranuclear areas that govern ocular mobility

CONTINUED FOLLOW UPS

- I am continually seeing the patient for continued in-office vision rehabilitation therapy and follow up appointments.
- Since her first follow up visit, she has not had any diplopia from her initial IRET. She has been slowly practicing driving and reports intermittent distance blur that is corrected after blinking quickly.
- In therapy, we have been working on improving her ocularmotor and vergence skills on top of initial vestibular activities given.
CHANGES IN STRABISMUS OVER TIME

In a normal situation, sensorimotor fusion maintains binocular alignment on a moment-by-moment basis, but there are two further mechanisms that maintain binocular alignment in the long term.

- First, a neurologic “vergence adaptation”
- Second, a muscular “muscle length adaptation”

Muscle Length Adaptation:
- Extraocular muscles can adapt their lengths in the same way as the other skeletal muscles throughout the body.
- With skeletal muscles responding to changes in stimulation by the gain or loss of sarcomeres, it is likely that abnormal or unguided vergence tonus, which changes the lengths of the extraocular muscles bilaterally, is largely responsible for changes in the angle of strabismus over time.

Vergence Adaptation:
- Retinal image disparity invokes a fusional vergence response (fast fusional vergence) which moves the eyes in opposite directions to eliminate the retinal image disparity.
- Feedback from fast fusional vergence that stimulates changes in tonic vergence, or vergence tonus, over time.
- However, maximum neuronal firing rates impose limits on how much misalignment can be compensated for by vergence adaptation.

WHY USE THE VESTIBULAR SYSTEM?

- The most important source of tonus of extraocular muscles is reflex in origin.
- Reflexes resulting from vestibular stimulation, to a large degree, control the position of the eyes in space.
- The vestibular system allows for subthreshold stimulation to the EOMs.
- The VOR allows for equal yoked muscle stimulation even in the abnormal eye posture, leading to muscle length adaptation.
- Which in turn can lead to increased binocularity and cortical processing of fusion.
- Linear VOR activates accommodative vergence.
- Activation of the vestibular system deactivates the occipital visual cortex.
- Allows a potential mismatch between two incongruent or misleading sensory inputs to be suppressed by shifting the sensory weight to the dominant or more reliable modality.
- If there is sensory fusion dysfunction, this allows for the vestibular system to dominate EOM tone.

REFERENCES

LEARNING OBJECTIVES

- To recognize distinct characteristics of congenital nystagmus
- To identify various forms of congenital nystagmus
- To review management options for congenital nystagmus

WHAT IS NYSTAGMUS?

Nystagmus is an involuntary, periodic eye movement caused by a drift of fixation, followed by a refixation saccade back to fixation. Essentially, it is poor maintenance of fixation.

CHARACTERISTICS OF CONGENITAL NYSTAGMUS

- Age of onset
  - First 6 months of life
- Waveform
  - Pendular vs jerk
    - Pendular: smooth, equal in both directions
    - Jerk: slow phase towards defect eye, fast phase towards fixating eye
- Direction
  - Horizontal
- Null position
  - Laterally
  - With accommodation
- Frequency
  - Increases with fixation effort
  - Convergence dampens width but increases frequency

TYPES OF CONGENITAL NYSTAGMUS

- Infantile idiopathic nystagmus
- Manifest latent nystagmus
- Albinism
- Spasmus Nutans
INFANTILE IDIOPATHIC NYSTAGMUS
Most common type
No underlying eye condition or neurological problems present
Bilateral, conjugate, occurring in horizontal phase, pendular or jerk waveform
Strabismus not common, good stereopsis often present

MANIFEST LATENT NYSTAGMUS
Nystagmus present with both eyes open but when only one eye is being used for fixation
(other eye is suppressed)
Increase in amplitude when one eye is occluded
Horizontal, jerk nystagmus with fast phase in direction of viewing (fixating) eye
Associated with strabismus
Infantile esotropia most common

ALBINISM
Oculocutaneous albinism – lack of pigmentation in the eyes, skin, and hair
Ocular albinism – no apparent lack of pigmentation in hair or skin, only visual system is affected
Changes in eyes and visual pathway:
Iris transillumination
Foveal hypoplasia
Retinal hypoplasia
Reduced myopia
Abnormal crossing of optic nerves at chiasm
Congenital nystagmus
Other: esotropia, jerk or pendular waveform, null zone

SPASMUS NUTANS
Triad: nystagmus, head nodding, head torticollis
Intermittent, fine, high frequency, pendular dissociated nystagmus
Head nodding and torticollis compensatory to improve vision
Initiates vestibular-ocular reflex for suppressing ocular oscillations
Onset is between 6-12 months and disappears after 1-2 years

MANAGEMENT
Lenses
Prisms
Vision therapy

LENSES
Contact lenses correct a refractive error better than spectacles
Moves with the eye, correction remains optimal
Improves visual acuity, but no change in nystagmus frequency
PRISMS

Base-out prisms
- Exploit convergence dampening

Yoked prisms
- Shifting eyes to null position

VISION THERAPY

Goal is to lessen nystagmus by increasing voluntary control of nystagmus and stabilizing fixation
- There is no cure for congenital nystagmus, but we can learn to control it

Visual-vestibular therapy with post-rotary nystagmus
- Spin up to 10x with eyes closed and head tilted 30 degrees down to place SCC in horizontal plane -> open eyes then work on fixation activity to dampen post-rotary nystagmus

After-image transfer
- Flash vertical line and look at white wall in the dark -> ask if they can make the line go faster -> then ask if they can slow it down

Convergence therapy
- Camp duftstät = works more on fixation recovery w/ smooth vergence

CASE PRESENTATIONS

CASE #1
A 4-month-old boy presented to the office for an eye exam. Mother reports inward turn of OS noticed 1 month ago and eye shaking noticed since birth.

- Pertinent findings:
  - -4/CET at distance and near
  - Jerk nystagmus (fast beat to left, slow drift to right)
  - Bi-temporal, full to near OD; limited adduction OS; full monocularly OD/OS
  - Retinoscopy: +2.00 OU
  - Blonde fundus, lighter hair, skin and eyes compared to mother and father

- Diagnosis:
  - Hyperopia OU
  - Infantile Esotropia OS
  - Congenital nystagmos
  - Suspect oculocutaneous albinism

- Treatment:
  - +0.50 lenses
  - Wide binasals
  - Referral for genetic testing

- Therapy:
  - Rotational activities
    - Dry corridors flash EG and raise right to promote left adduction and nasal to temporal motion promoting
    - Can use interesting targets to promote reaching to the left
    - Post-rotatory nystagmus. Spin in OR. Spin. Add sensation to both eyes, then answer with hand firmly placed and touch an object at a distance
    - This promotes yoked bilateral input to EOMs from vestibular system (ESC), and convergence helps to dampen nystagmos
    - Lateral tracking
      - Pronose all objects with lateral gaze, binasal prevents cross fixation without full occlusion
      - Ex. Feeding, diaper changing, etc from the side (L>R)
**CASE #2**

A 27-year-old female presented to the office for a vision therapy evaluation. She has done VT in the past and would like to restart. OHS of nystagmus since childhood.

- **Pertinent findings:**
  - 20°/CAT (OS preference) & 20° Hyper at distance
  - 10-20° CAT (OS preference) & 10-20° Hyper at near
  - W/ES alternating suppression at distance and near
  - Stereopsis: 0/3 Long
  - Pendular nystagmus

- **Diagnosis:**
  - Alternating Esotropia
  - Congenital Nystagmus

**Therapy**

- **Rotational activities**
  - Fort water nystagmus: sign to show - 30° to both sides, then open and have patient fixate and touch on object at near
  - Name it to the exact visual after patient stops

- **After image transfer**
  - Flash central fix, then have patient fixate on a hard target - A/A. Itable to allow eye movement to be turned, then try to slow and control it

- **Vergence activities**
  - Break away - Jump
  - Transient– Jump through

**REFERENCES**


**THANK YOU!**