Vision Rehabilitation for Patients with Traumatic Brain Injury

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Residency Trained Optometrist in Vision Therapy and Rehabilitation
What is Vision Rehabilitation?
  - Definition
  - Neuroplasticity
  - Optometry’s Role
  - Goals of Vision Therapy
  - Improvements to expect & Prognosis Factors

Guidelines for Vision Rehabilitation
  - When working with TBI patients
  - Key Concepts
  - Vision Rehabilitation Sequence

Vision Rehabilitation Procedures

Does it work?
  - Current research

How to incorporate into your primary care practice

Resources
How does TBI affect VISION?

- Occipital Lobe (primary visual cortex)
- Parietal Lobe (spatial inattention, perception)
- Temporal Lobe (spatial organization, object recognition)
- Frontal Lobe (initiates voluntary saccades and pursuits)
- Midbrain and Pons (cranial nerves)

70% of our brain as Something to do with VISION
An individualized treatment regimen prescribed to a patient in order to:

- Provide medically necessary treatment to normalize diagnosed visual dysfunctions
  - Vergence
  - Accommodation
  - Oculomotor

- Improve visual comfort, ease and efficiency

- Enhance visual performance to meet defined needs of the patient

- Improve visual information processing
  - Spatial organization
  - Object perception
  - Visual memory
  - Visual attention
  - Integration with other sensory modalities (motor, vestibular, auditory, etc)
Brain (visual system) is able to create new connections and fortify old ones by experience.

Learning and plasticity can occur by myelination formation or re-modeling white matter.

Neurogenesis continues throughout lifetimes.

Examples:
- Rapid functional plasticity in primary somatomotor cortex and perceptual changes after nerve block through MRI.
- Visual development in adult amblyopes.
Optometrists can diagnose, manage, and treat binocular vision problems:
- Strabismic
- Non-Strabismic
- Visual Perceptual

Without appropriate treatment, we are ignoring 25-57% of our TBI population needs.

<table>
<thead>
<tr>
<th>Dysfunction of:</th>
<th>% of TBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accommodation</td>
<td>41%</td>
</tr>
<tr>
<td>Vergence</td>
<td>56%</td>
</tr>
<tr>
<td>Oculomotor</td>
<td>51-57%</td>
</tr>
<tr>
<td>Strabismus</td>
<td>25-36%</td>
</tr>
<tr>
<td>Cranial Nerve Palsy</td>
<td>7-10%</td>
</tr>
</tbody>
</table>
Goals of Vision Therapy

- Alleviate signs and symptoms

- Achieve desired visual outcomes
  - Clear, comfortable, single binocular vision
  - Efficient coordination of visual functional skills
  - Efficient visual information processing

- Meet the patient’s needs

- Improve the patient’s quality of life

- Return to daily activities
**Oculomotor Skills**
- Improved accuracy and speed of pursuit and saccades
- Reduced number of re-fixations and regressions while reading
- Increased span of recognition

**Vergence**
- Increased vergence ranges, speed, facility
- Reduced eyestrain, headache with near tasks

**Accommodation**
- Increased amplitude, flexibility, facility
- Improved quality and stability of near vision

**Comfort** + **Efficiency** + **Accuracy** = **Performance**
Most visual efficiency cases have a very good prognosis (72-90% in CITT 2008)

Important factors:
- Accurate diagnosis (rule out disease/trauma)
- Age/understanding of patient
- Treatment appropriate for diagnosis
- Patient compliance and motivation
- Stage in the grieving process
- Degree of brain injury
Managing Expectations

- Rehabilitation is a process that takes time

- Initially program can cause symptoms to be exacerbated

- Manage the increased symptoms while strength training
  - Modify amount of time spent on exercises
  - Slowly increase amount of exercises performed
  - Monitor log for delayed symptoms
  - Symptoms should not exceed 7 or 8/10
Guidelines for Vision Rehabilitation

Working with Patients with TBI
Extent and severity of symptoms may not correlate directly with degree of abnormality in clinical findings

May have certain ability but at expense of excessive effort

Visual hypersensitivity
  - Real
  - May not be over-reacting (most want to return to their normal life!)

Mechanisms that normally help to function efficiently and comfortably are compromised
Environment

- Quiet
- Avoid Fluorescent lighting
- Reduce clutter
Communication

- Speak slowly
- Soft voice
- Slow movements
- Ask for them to repeat instructions
Procedures

- Gain their attention
- Confirm they understand the task
- Give instructions in small steps
- Give breaks
- Increase demand in small increments
  - Amount of time
  - Level of difficulty
Guidelines for Vision Rehabilitation

Key Concepts
General Principles and Guidelines

- Determine a level at which the patient can perform easily

- Emphasize that changes must be made within their own visual system (we can’t do the work for them!)

- Set goals (for both patient and doctor)

- Use techniques that provide them with feedback (diplopia, blur, parallax, float….)

- Relate how exercises will impact daily living
2 Approaches to VT

Classical/Structural

- Visual processing as it relates to anatomy, neurophysiology, and sensorimotor substrates
  - Muscles and nerves

- Mechanics of vergence, accommodative and oculomotor systems

- Bring measurements into the “comfort zone” or “norms”
  - Sheard, Percival, Morgan

Functional/Developmental/Behavioural

- Emphasizes visual development, function and performance in the context of their total behaviour

- Treatment is based on individual’s abilities, needs, and goals

- A “visual stress test”

  Looks into fatigue, variability, stamina
**Degree of Holistic Approach**

**Functional**
- Develops visual functional skills and abilities
  - Oculomotor skills
  - Accommodative rock
  - Fusion range extension

- Looks how the visual system develops and integrates visual information

**Behavioural**
- Added holistic approach to underlying organismic processes to behaviour
- Incorporates procedures related to:
  - Movement
  - Awareness
  - Stress reduction
  - Visual information processing
  - Central-peripheral organization
  - Visuomotor function

- Higher degree of holistic:
  - Syntonics
  - Bates (natural vision improvement)
  - Chinese Acupressure treatment
Combining the 2 Approaches

Work on functional visual skills classically while addressing the developmental and visual perceptual processing.
General Therapy Sequence

Phase 1
- Anti-suppression
- Awareness

Phase 2
- Monocular

Phase 3
- Bi-ocular
- Binocular
- Accomm
- Vergence

Phase 4
- Integration
- Flexibility
- Stamina

Phase 5

Diagram shows a cyclical sequence of therapy phases, each focusing on different aspects of visual and ocular function.
Therapy Sequence: Tips

- Expand both but emphasize difficult area
- Build ability and stamina before flexibility
- Start with peripheral targets and work towards central targets
- Each eye has to learn how to work on its own before they are expected to work equally to the partnership
- Can use lenses, prism
- Incorporate both free space and equipment
Begin therapy by slowly stressing the direction of difficulty:

- Exophoria with low base out – emphasize BO
- Esophoria with low base in – emphasize BI
- Accommodative Insufficiency – minus lenses
- Accommodative Excess – plus lenses
To increase accommodative abilities:

- Begin by stressing direction of difficulty
- Later work on both relaxation and stimulation
- Emphasize the “feeling” of effort
- Equalize right and left eyes’ skills
- Emphasize amplitude, then facility, fine control, and stamina
To increase fusional vergence ranges:

- Maintain accommodation at the plane of regard and change the stimulus to the vergence system

- Maintain vergence at the plane of regard and change the stimulus to accommodation

- Emphasize amplitude, then facility, fine control, and stamina
Case Example
Chief Complaint: 33 year old male lawyer sustained concussion from MVC; since has had headaches, double vision with reading, eye strain and discomfort at near, words moving on the page, dizziness with movement.

<table>
<thead>
<tr>
<th>Exam results</th>
<th>Interpretation</th>
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<tr>
<td>Phoria</td>
<td></td>
</tr>
<tr>
<td>Distance: 2 XP</td>
<td></td>
</tr>
<tr>
<td>Near: 14 XP</td>
<td>Higher exo at near</td>
</tr>
<tr>
<td>NPC</td>
<td>15/20, 18/25, 20/30</td>
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<tr>
<td>NRA/PRA</td>
<td>+1.00/-1.00</td>
</tr>
<tr>
<td>AA</td>
<td>OD 3D, OS 3.5D</td>
</tr>
<tr>
<td>MEM</td>
<td>OD +1.25, OS +1.25</td>
</tr>
<tr>
<td>BAF</td>
<td>5 cpm (- longer)</td>
</tr>
<tr>
<td>MAF</td>
<td>OD 7 cpm , OS 7.5 cpm</td>
</tr>
</tbody>
</table>

Dx: Convergence Insufficiency and Accommodative Insufficiency
VT Program:

Goal: Anti-Suppression and Awareness

- Discussion of Vision Problem and Goals
- Marsden Ball Tracking
- Space Fixator
- VO Star
- Batwing
- Cheiroscope
VT Program:

- **Goal:** Equalize the skills between both eyes
- **Strategies:** distances or lenses

  - Monocular Accommodative Rocks (+/-)
  - Hart Chart Saccades
  - Near-Far Hart Chart Saccades
  - Monocular Lens Sorting
  - Mental Minus (clear-blur-clear)
Goal: Develop monocular skills with binocular awareness

- Monocular Fixation in a Binoocular Field (Red Acetate with R/G glasses)
- Split Prism Techniques
- Split Vectograms
- R/G tracking/workbooks
- Red Rock
- GTVT Chart
VT Program:

Goal: Integrate both eye together and improve Fusional Ranges and Accommodation

- Brock String
- Vectograms
- Tranaglyphs (Stationary and Sliding)
- Bernellscope
- Batwing
- Computerized Vergence Program

- Eccentric Circles
- Lifesaver Cards
- Aperture Rule
- Binocular Accommodative Flippers
VT Program:

Correct
- If you want to look at the green bead, it is single
- String “X” indicates you are paying attention to both eyes
- Where the strings meet is where you are looking
- Bead is in the middle of the “X”

Incorrect
- You are looking farther away than you want to
- Must look closer
- Look towards your nose
- Move your eyes together so they “touch”

Incorrect
- You are looking closer than you want to
- Must look farther away
- Look farther down the string
- Imagine looking down a tunnel

Incorrect
- Means you are suppressing or ignoring information received by one eye
- You want to see 2 full strings
- You need to make your brain pay attention to both eyes again
- Do either:
  - Blinking
  - Tapping the bead you want to look at
  - Lightly tapping your forehead
VT Program:

Convergence:

Ensure that you see all the shapes:

For CONVERGENCE: Slowly move the slider out from the thumb tag until you see double or something disappears. Stop, and try to re-fuse the images or make images appear. If you are able to, continue to move the slider out until you are unable to fuse the two images any longer.

- Note what the number is on the top (called the “break” – when your binocular system breaks apart)

Nudge the slider in slightly and try again to re-fuse. If you are unable to do so for a few seconds, continue to nudge the slider inward a little bit and re-attempt

Once you are able to re-fuse the images, hold the image single for 5-10 seconds, then rest.

- Note what number is on the top (called the “recovery” – when you are able to recover your binocular vision)

FOR DIVERGENCE: Repeat, but turn the tranaglyph upside down so that the thumb tag is now on the left side.

TIPS:

- To help with re-fusing, use the red stick, by slowly moving the stick towards you (for convergence) or behind the tranaglyph (for divergence)
- Remove the fogged sleeve to help with divergence (which allows you to look past the tranaglyph to a distant target)
VT Program:

Goal: Integrate both eye together and improve Oculomotor skills

- Fixation Stability
- Mazes/Groffman Tracings
- Marsden Ball
- Pegboard Rotator
- Four-corner saccades
- Hart Chart saccades

- Computer Training Techniques
- Michigan Letter Tracking
- Kirschner Arrows
- PBQD slap tap
- Saccadic Workbook
There are many areas of brain needed for tracking:

- Pursuits/Saccades: Brainstem (Pons, Midbrain)
- Fixation: FEF, Parietal lobe & Prefrontal cortex (for attention)
- Different pathways
- Both need to know where objects are in space
Letter Tracking

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz

Hoft  orn  holby  kelm  croe  peurot.  Ix
rish.  Dop  fult  hurs  lim  kreph  thoz
ffol  krik  nul  guar  quim.  Auth  quat
rulk  tay  suid  meve  neb  poj  durat.
Ceth  boft  kalb  non  rem  turz  bured
dir  ench  verf  thay.  Fog  chat  aqite.
Bague  guide  tere  gusk  malf  bache
deph  lect.  Wald  mUnd  newk  poY  fam
wemp  snal  fron.  Mex  jop  Yonde  baza

Min.  Sec.

Arom  bixto.  Heen  dolk  roche  hekis
### Visual Tracking and Scanning

#### GROFFMAN MAZES

**PHONETIC FOCUS**

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<td>trasp</td>
<td>slans</td>
<td>grags</td>
<td>wam</td>
<td>clast</td>
</tr>
</tbody>
</table>
Pegboard Rotator
Saccades
Kirschner Arrows
Goal: Improve stamina, enhance skills, achieve accommodation-convergence flexibility

- Any Binocular Technique with +/- Lenses (BIM/BOP)
- Vectrograms/Tranaglyphs with Jumps
- Binocular Prism Jumps with Saccades
- Computerized Vergence Program with Jumps
- Eccentric Circles or Lifesaver with Tromboning
- Load activities, adding:
  - Speed
  - Metronome
  - Balance board
Goal: Improve processing visual information

- Visual Memory
- Figure Ground
- Visualization
- Visual-Motor Integration
## Case Example:

### Final Results

<table>
<thead>
<tr>
<th></th>
<th>Pre VT results</th>
<th>Post VT results</th>
<th>Interpretation</th>
<th>Norms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoria</td>
<td>Distance: 2 XP&lt;br&gt;Near: 10 XP</td>
<td>Distance: tr XP&lt;br&gt;Near: 8 XP</td>
<td>Higher exo at near&lt;br&gt;Well compensated</td>
<td>Ortho – 2XP</td>
</tr>
<tr>
<td>NPC</td>
<td>10/15, 13/15, 15/17</td>
<td>3/5, 3/5, 4/6</td>
<td>Normal, stable</td>
<td>At least 5/10</td>
</tr>
<tr>
<td>AC/A</td>
<td>2:1</td>
<td>2:1</td>
<td>Low</td>
<td>4:1</td>
</tr>
<tr>
<td>PFV/NFV (40cm)</td>
<td>BO: 4/8/6 , BI: x/8/6</td>
<td>BO: 12/25/18&lt;br&gt;BI: 12/20/16</td>
<td>Normal</td>
<td>BO: 9/19/10&lt;br&gt;BI: x/7/4</td>
</tr>
<tr>
<td>NRA/PRA</td>
<td>+1.00/-1.00</td>
<td>+2.00/-3.00</td>
<td>Normal</td>
<td>+2.00/-2.25</td>
</tr>
<tr>
<td>AA</td>
<td>OD 3, OS 3.5</td>
<td>OD 10, OS 10</td>
<td>Normal</td>
<td>Min = 15 - (Age/4)</td>
</tr>
<tr>
<td>MEM</td>
<td>OD +1.25, OS +1.25</td>
<td>OD +0.50, OS +0.50</td>
<td>Normal lag</td>
<td>+0.50 to +0.75</td>
</tr>
<tr>
<td>BAF</td>
<td>5 cpm</td>
<td>9 cpm</td>
<td>Normal</td>
<td>8 cpm</td>
</tr>
<tr>
<td>MAF</td>
<td>OD 7 cpm&lt;br&gt;OS 7.5 cpm</td>
<td>OD 12 cpm&lt;br&gt;OS 12 cpm</td>
<td>Normal</td>
<td>12 cpm</td>
</tr>
</tbody>
</table>

- Improvement in Convergence Insufficiency Symptoms (double vision, eye strain and discomfort at near, words moving on the page, etc.)
Post VT Maintenance

- 3 month re-check, giving them homework 2-3 times a week

- Then, if needed, wean the procedures to once a week (or biweekly) for another 3 months

- Yearly exams
Does it work?
12 non-strabismic individuals with mTBI and diagnosed vergence and accommodative disorders participated.

6 weeks (2 sessions/wk, 3 hours each); half did oculomotor training (OMT) and half did placebo (P) training.

Results:
- Improved amplitude and peak velocity of vergence (pfv and nvf) and accommodation (monocular and binocular).
- Improved stereoacuity.
- Improved visual attention.
- Reduced near symptoms (CISS score).
- No change in patients that did placebo VT.


12 subjects with mTBI participated in either oculomotor training (OMT) or sham training (ST).

6 weeks, 2 sessions a week. Trained vergence, accommodation, version in randomized order across sessions.

Visual attention assessed by VSAT

Results:
- Over 80% of abnormal parameters significantly improved
- Reading rate improved
- Amplitudes of vergence, accommodation improved
- Saccadic eye movements improved in rhythmicity and accuracy
- Improved visual attention and CISS score

5 adults with stroke and 9 adults with TBI
8 weeks of training, 2 sessions/week

Training included single- and multiple-line simulated reading, as well as basic versional tracking (fixation, saccade, and pursuit) using infra-red eye movement recording technology

Internal oculomotor visual feedback in isolation (4 weeks) or concurrent with external oculomotor auditory feedback (4 weeks)

Results:
- Improved objective accuracy with versional tracking
- Improved reading ability

13 control normal BV adults; 4 convergence insufficiency adults
All participated in 18 hours of VT

Results:
- Reduction in NPC and NPC recovery point
- Reduction in Near Phoria
- Improved PFV, average peak velocity of convergence
- Significant increased functional activity within the frontal areas, cerebellum, and brain stem significantly

Functional activity and vergence eye movements were quantified from 7 BV normal and 4 CI patients before and after 18 h of vergence training.

Results: CI patient measurements after vergence training were more similar to levels observed with BV normal
- Increased fMRI activity levels
- Increased speed in convergence response
- Improvement in CISS score

12 BV normal patients and 4 CI patients. CI patients underwent 18 hours of VT.

Results: After VT, peak velocity and exophoria magnitude improved significantly in CI patients.

The NIH funded a study to determine the best treatment protocol for Convergence Insufficiency.

The results indicated that in-office VT is the treatment of choice as it is the most effective treatment for convergence insufficiency.
Randomized, multi-centered clinical trial

221 children ages 9-17 years with CI

Subjects subdivided into 4 groups and underwent 12 weeks of either:

<table>
<thead>
<tr>
<th>VT</th>
<th>Reduced symptoms by:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office based VT</td>
<td>73%</td>
</tr>
<tr>
<td>Home-based pencil push-up (PPU) VT</td>
<td>43%</td>
</tr>
<tr>
<td>Home-based computerized VT + PPU</td>
<td>33%</td>
</tr>
<tr>
<td>Office-based placebo therapy</td>
<td>35%</td>
</tr>
</tbody>
</table>

Results:
- Remained symptom free 1 year later
- ~90% of those CI subjects who initially had reduced accommodative amplitudes and facilities also developed normalized accommodative skills with the VT program
Vision Therapy Changes Lives!
How to incorporate VT into your primary care practice
Decide what conditions you are comfortable treating and what tools you will need.

Compose written instructions to hand out.

Schedule an instructional session to review the techniques together.

Sell or rent the required equipment to your patient.
# Home Vision Therapy Kit

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>Instructions</td>
<td>Photocopy</td>
</tr>
<tr>
<td>Brock String</td>
<td>$2</td>
</tr>
<tr>
<td>Sliding Tranaglyph</td>
<td>$15</td>
</tr>
<tr>
<td>Red/Green Bar Reader</td>
<td>$10</td>
</tr>
<tr>
<td>Flippers (+/-2.00)</td>
<td>$19</td>
</tr>
<tr>
<td>Near and Far Hart Charts</td>
<td>Photocopy</td>
</tr>
<tr>
<td>Barrel Card</td>
<td>$3</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>$50</strong></td>
</tr>
</tbody>
</table>
Home Therapy System (HTS)

- Your office registers for an institutional account (free)
- Purchase DVD/codes for each patient, which will be linked to your account
- Software, Glasses, and Flipper Set: $110 USD (Your cost)
What is “In-Office” VT:

- Usually weekly sessions of 45 minutes
- Homework to be completed at least 4 times between sessions
- Activities progress week by week
- The patient’s progression is monitored and the program can be individualized for optimal results

Can get in touch with local clinics offering VT for specific info:

- Do they have a referral form?
- What kind of patients do they treat?
- What is their background/training?
- What is their fee?
What is “In-Office VT”
What is “In-Office VT”
Where to find out more
How do I get involved?

- **Canadian Optometrists in Vision Therapy and Rehabilitation (COVT&R)**
  - Annual Meeting (August)

- **College of Optometrists in Vision Therapy and Rehabilitation (COVD)**
  - Tour d’Optometry for students
  - Annual Meeting for students and optometrist (April)
  - Can become a fellow (essays, clinical experience, exam, and interview)

- **Optometric Extension Program (OEP)**
  - Courses available

- **Vision Therapy Courses by Robert Sanet**
  - Courses available

- **Neuro-Optometric Rehabilitation Association**
  - Annual Meeting
Where do I buy the equipment?

Websites:
- Bernell - www.bernell.com
- Optego - www.optego.com
- McCray Optical - www.mccrayoptical.com
- Fresnel Prisms (prisms and bangerter foils) - www.fresnel-prism.com
- GoodLite - www.good-lite.com
- HTS Inc - www.visiontherapysolutions.net

Can discover more at the annual meetings and exhibits


Questions?

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