Vision Rehabilitation Following Stroke

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Topic Objectives

To identify the
  - more common vision conditions evident following stroke, as well as the primary associated vision symptom
  - treatment options and associated evidence-based medicine for managing these common vision conditions following stroke.
Vision and stroke:
- What is optometry’s role?

Overview of:
- Ophthalmic terminology
- Primary eye care tips
- Typical vision conditions and associated primary vision symptoms
- Treatment options for more common vision problems
How many years have you been involved in stroke care/rehabilitation?

A. <1 year
B. 1–5 years
C. 6–10 years
D. >10 years
Do you refer your stroke patients for vision evaluation and/or rehabilitation?

A. Yes
B. No
C. Sometimes
Role of Optometry

To diagnose and/or treat (optically and/or with vision rehabilitation) vision disturbances to optimize vision function for use in a patient’s:

- overall rehabilitation regimen
- activities of daily independent living (ADLs), thereby impacting overall quality of life (QOL)

Finding an optometrist specializing in neuro-optometric rehabilitation near you:

- www.covd.org
- www.nora.cc
accommodation: the ability to change focus and maintain a clear image of an object (when looking from far to near and vice versa), using the eye’s crystalline lens-based mechanism.
Terminology

- **accommodative amplitude**: the closest point of clear vision, typically performed monocularly.
accommodative facility: the ability to maintain clarity of vision when looking from near to far/far to near repeatedly, accurately, and on command. This is may be performed monocularly or binocularly.
versional ocular motility:

- the conjunctive movement of the eyes to follow targets moving laterally, vertically, or obliquely in one plane, with no change in depth (i.e., 2-dimensional eye movements in the x–y plane)

- may be tested monocularly or binocularly.

- includes
  - fixation
  - saccades
  - pursuit
**Fixation:** an eye movement in which the eyes are fixed on a target to maintain the target’s image on the fovea and may be tested monocularly or binocularly.
saccades: are rapid, step-like conjugate eye movements which redirect the line of sight from one position (or object) in space to another and may be tested monocularly or binocularly.
**pursuit**: is a slow, continuous conjugate eye movement used when the eyes follow a slowly-moving object and may be tested monocularly or binocularly.
**Terminology**

- **fusion**: single, cortically-integrated vision under binocular viewing conditions

- **vergence**: the disjunctive movement of the eyes to track targets moving in depth (i.e., along the z-axis)
heterotropia (ie., strabismus): the position of the eyes when fusion is not disrupted (i.e., under normal binocular viewing conditions)

heterophoria: the position of the eyes when fusion is disrupted
near point of convergence: the closest point of binocular, fused, single vision.
**Terminology**

- **vergence facility**: the ability to maintain single vision when looking from near to far/far to near repeatedly, accurately, and on command. This is performed under binocular viewing conditions.

- **stereopsis**: relative depth perception
Accommodation is the perception of single, cortically-integrated vision under binocular viewing conditions.

1. True
2. False
Tips for Primary Eye Care Exam: Prescribing Spectacles

- For those with signs or symptoms of gait, vestibular, or cognitive dysfunction:
  - multi–focal lenses are:
    - 1) typically contraindicated for ambulation
    - 2) appropriate for non–ambulatory tasks
  - prescribe single vision distance correction for ambulation and single vision near correction for prolonged reading/computer use
Tips for Primary Eye Care Exam: High Yield Tests

- Accommodative assessment for pre-presbyopes
  - monocular amplitudes
  - monocular (or binocular) lags

- Vergence ocular motor assessment
  - cover test at far and near, as well as near point of convergence (NPC)

- Versional ocular motor assessment
  - monocular and binocular motilities

- Confrontation visual field testing
## Common Vision Deficits/Their Primary Associated Symptoms Evident Following Stroke

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## Results of Ciuffreda et al. (2007)

<table>
<thead>
<tr>
<th>Ocular motor dysfunction</th>
<th>TBI (%)</th>
<th>Most common anomaly (TBI)</th>
<th>CVA (%)</th>
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</tr>
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<tbody>
<tr>
<td>Accommodation</td>
<td>41.1</td>
<td>Accommodative insufficiency</td>
<td>12.5</td>
<td>Accommodative infacility</td>
</tr>
<tr>
<td>Versional</td>
<td>51.3</td>
<td>Deficits of saccades</td>
<td>56.7</td>
<td>Deficits of saccades</td>
</tr>
<tr>
<td>Vergence</td>
<td>56.3</td>
<td>Convergence insufficiency</td>
<td>36.7</td>
<td>Convergence insufficiency</td>
</tr>
<tr>
<td>Strabismus</td>
<td>25.6</td>
<td>Strabismus at near</td>
<td>36.7</td>
<td>Strabismus at far</td>
</tr>
<tr>
<td>CN palsy</td>
<td>6.9</td>
<td>CN III</td>
<td>10</td>
<td>CN III</td>
</tr>
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</table>

Accommodation

- Principal symptom: Constant or intermittent blur
- Neurological correlates:
  - Mediated by the autonomic nervous system (ANS)
    - primarily the parasympathetic system to stimulate or increase the accommodative response
    - secondarily the sympathetic system to inhibit or reduce the accommodative response
Accommodation: Neurological Correlates

- Visual cortex to parieto–temporal (PT) area to the Edinger–Westphal (EW) nucleus in the pre–tectum

- At the EW nucleus, autonomic input (from parasympathetic fibers) is received to form the motor command

- Combined autonomic and motor neurons travel via the oculomotor nerve from the EW nucleus to the ciliary ganglion (where sympathetic fibers join CN III without synapsing) to the short ciliary nerve and then to the ciliary muscle

- End result:
  - a change in the contraction of the ciliary muscle
  - consequent change in crystalline lens shape and effective state of accommodation
Accommodative Deficits: Compensatory Treatment Options

- Lenses may be prescribed for near vision tasks either:
  - In lieu of restorative accommodative training
  - In conjunction with restorative accommodative training
  - Following restorative accommodative training (examples: those who work on computer for 8–10 hours daily may require near vision glasses to prevent eyestrain and headaches regardless of accommodative integrity)
Accommodative Deficits: Restorative Treatment Options

- Equalize accommodative amplitudes
- Work on improving the weaker aspect of focusing; i.e., if a patient cannot:
  - relax the accommodative state, work on near–far focusing
  - increase the accommodative state, work on far–near focusing
Accommodative Deficits: Restorative Treatment Options

- Work on maintaining the ability to:
  - rapidly change focus on command and repeatedly over time
  - sustain focus for extended periods of time

- Training may be performed:
  - using lenses
  - in free space regarding targets at different viewing distances
Accommodation: Relevant Publications


Principal symptoms:
- loss of place, skipping lines, and slower speed when reading
- difficulty shifting gaze during ambulation

Neurological correlates – Integrated pre–motor neural activity occurs in similar areas for vertical saccades, horizontal saccades, and horizontal pursuit:
- frontal lobe
- parietal lobe
- basal ganglia
- superior colliculus
- cerebellum
Vertical Saccades
- Pre–motor neural area: rostral mesencephalon

Horizontal pre–motor neural components:
- Saccade: excitatory burst neurons in the paramedian pontine reticular formation (PPRF) => project directly to the oculomotor neuron for horizontal saccades
- Pursuit: pursuit neurons in the medial vestibular nuclei and prepositus hypoglossi => project directly to the oculomotor neuron for horizontal pursuit
Integrated pre-motor neural components for fixation include:

- Frontal eye fields
- Supplemental eye fields
- Parietal eye fields
- Right prefrontal cortex (for attention)
- Right posterior parietal cortex (for attention)
Encourage a typoscopic approach (i.e., create an aperture/window highlighting the text of regard while obscuring non-pertinent text)
Basic scanning and searching exercises
- Concentrate on accuracy
- Gradually build up speed

Text size is often not the issue:
- *The space between the lines is often more critical.*
Examples of versional oculomotor restorative treatment techniques:

- Small-angle (i.e., Ann Arbor/Michigan tracking, pencil/paper tracings and mazes, Pegboard Rotator, Groffman computer scan/search/coding/perceptual speed)
Examples of versional oculomotor restorative treatment techniques:

- **Medium-angle** (i.e., Hart Chart, Pegboard Rotator, Keystone Rotator, Groffman computer pegboard/visual motor integration/visual tracings)

- **Large-angle** (i.e., 4-corner saccades, Keystone Rotator)
Versional Ocular Motor Deficits
Restorative Treatment Options
Versional Ocular Motor Deficits: Restorative Treatment Options
Versional ocular motor deficits have been reported in visually symptomatic stroke patients with what percentage?

1. 10–19%
2. 20–29%
3. 30–39%
4. 40–49%
5. 50–59%
Versional Ocular Motility: Relevant Publications


Versional Ocular Motility: Relevant Publications


Versional Ocular Motility: Relevant Publications


Vergence Ocular Motility

- **Principal symptom:** constant or intermittent eyestrain/diplopia that is reduced or eliminated with monocular occlusion

- **Neurological correlates** – Pre–motor neural innervation:
  - Mesencephalic reticular formation, with three of the better–studied types of vergence cells being:
    - Tonic: respond to change in vergence angle
    - Burst: respond to change in vergence velocity
    - Burst–tonic: respond to changes in both vergence angle and velocity
Vergence Ocular Motility: Neurological Correlates

- Pre-motor neural innervation (continued):
  - Medial longitudinal fasciculus
  - Cerebellum
  - Frontal eye fields
  - Role in generating vergence response of the abducens and oculomotor interneurons: not clearly elucidated
Vergence Ocular Motor Deficits: Compensatory Treatment Options

- To compensate for constant diplopia, decompensated phoria, or fixation disparity, incorporate:
  - Fusional prism, if possible
Vergence Ocular Motor Deficits: Compensatory Treatment Options

To compensate for constant diplopia, decompensated phoria, or fixation disparity, incorporate:

- Varying degrees of occlusion may be required if fusion is not achievable:
  - Selective (to insure peripheral fusion, while inhibiting central simultaneous perception)
  - Graded (i.e., using Bangerter foils or other such translucent materials to blur/degrade image)
  - Complete (i.e., with an opaque eyepatch)
Once person presents with fusion (even if intermittent), then:

- Stabilize vergence in primary gaze (ramp and step) at far and near viewing distances
Then:

- Work on facility and sustainability of fusional vergence at far and near viewing distances
Vergence Ocular Motor Deficits: Restorative Treatment Options
Vergence Ocular Motor Deficits: Restorative Treatment Devices
Vergence Ocular Motility: Relevant Publications


Vergence Ocular Motility: Relevant Publications


Visual–Vestibular Dysfunction: Principal Symptoms

- Similar for vergence and versional ocular motility, emphasizing:

  - *Increased dizziness and/or disequilibrium in/sensitivity to multiply-visually stimulating environments. Examples of stimulating environments/tasks include:
    a) Supermarkets
    b) Malls
    c) Motion sickness in a moving vehicle
    d) Scrolling on a computer
    e) Watching television or movies
Visual–Vestibular Interaction: Purpose

- **VOR**
  - Stabilizes the visual world while the head is in motion
  - Is utilized in most vestibular rehabilitation regimens
  - May be impaired in the presence of ocular motor deficits

- Improving and stabilizing ocular motor deficits may facilitate vestibular rehabilitative progress
CN III and VI communicate with CN VIII via the medial longitudinal fasciculus to generate the horizontal vestibulo-ocular reflex (VOR, also referred to as gaze stabilization)
Same as for versional oculomotor deficits without vestibular dysfunction, except:

- Start at a slower velocity and lower number of repetitions of saccades and pursuit, while patient is seated and minimal targets in the background.

- Systematically and gradually increase the:
  - velocity of the ocular motility
  - number of targets in the background

- Build to having the patient marching in place while performing these tasks in front of a multiply visually-stimulating background.
Same as for vergence ocular motility deficits without vestibular dysfunction, except:

- After stabilizing fusional vergence in primary gaze under static conditions:
  - Stabilize vergence 30 degrees right gaze (ramp, step) and then 30 degrees left gaze (ramp, step)
  - Stabilize dynamic vergence while the patient is performing a slow horizontal VOR (approx. 40–60 rotations per minute)
Vergence Ocular Motility Deficits and Vestibular Dysfunction: Treatment Options

- After stabilizing horizontal fusional vergence and a slow horizontal VOR:
  - Stabilize vergence 25 degrees upgaze (ramp, step) and then 25 degrees downgaze (ramp, step)
  - Stabilize dynamic vergence while the patient is performing a slow vertical VOR (approximately 40–60 rotations per minute)
Vergence Ocular Motor Deficits and Vestibular Dysfunction: Treatment Options
Vision Rehabilitation Software:
Visual–Vestibular Dysfunction: Relevant Publications


Visual–Vestibular Dysfunction: Relevant Publications


Impaired Visual Field Integrity: Neurological Correlates
Lateralized Visual Field Defects

- **Principal symptom**: missing a portion of peripheral vision

- Lateralized, post–chiasmal homonymous defects
  - More typical in stroke
  - May occur with or without inattention
  - Evident despite intact retina with unremarkable ocular health

- **Neural mechanism**:
  - Secondary to localized lesions (hemorrhagic or ischemic)
  - **NOTE**: *right-brain* lesions present often with inattention
Impaired Visual Field Integrity: Compensatory and Adaptive Treatment Options

- Scanning strategies

- Compensatory/ adaptation approaches

- In addition to the above, for those:
  - with inattention, application of yoked prisms, mirrors, and field expanding lenses may benefit
  - without inattention, application of sector prisms and spotting prisms may benefit
Impaired Visual Field Integrity: Relevant Publications


Impaired Visual Field Integrity: Relevant Publications


Which of the following are NOT among the common vision conditions related to stroke?

A. Visual field defect
B. Versional deficits
C. Vergence deficits
D. Corneal abrasion
E. Visual–vestibular disturbances
The purpose of today’s presentation was to increase familiarity and evidence-based medicine understanding with respect to the:

- more common vision conditions evident following stroke, as well as the primary associated vision symptom
- treatment options and associated evidence-based medicine for managing these common vision conditions following stroke.
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  - Optometric Extension Program Foundation
  - Neuro–Optometric Rehabilitation Association
Thank you!