Cortical/Cerebral Visual Impairment

What is it?

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Barry S Kran, OD, FAAO
Darick W Wright, MA, COMS, CLVT

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D Luisa Mayer, PhD. MEd
CVI Overview

Anatomy
Terminology
Case Example
Current Issues
Ocular Vision Impairment

Eyes, retina, optic nerves

- Significant uncorrected refractive error
- Media opacities (cataracts)
- Retinal lesions (colobomas)
- Retinal degeneration/dystrophy
- Optic nerve damage
Ocular Vision Impairment

Additional examples:

- Retina
  - Retinopathy of prematurity*
  - Achromatopsia
  - Leber congenital amaurosis
- Albinism (macular hypoplasia and reduced ON fibers crossing at chiasm)
- Optic nerve hypoplasia*

*Brain related visual difficulties may co-occur
Primary Visual Pathway

Ocular structures to Optic Chiasm

Optic chiasm to primary visual cortex

Accessed 11 July 2010
The Cerebrum

- Comprised of 4 lobes
- Cerebellum
- Facilitates complex behaviors
- Last portion to evolve in human brain
Frontal Lobes

- Attention
- Judgment
- Personality
- Emotion
- Memory
Parietal Lobe

- Sensory processing
- Sensation
- Spatial information
Occipital Lobe

- Visual Processing
- Visual Perception
Temporal Lobe

- hearing, speech, memory “library”
- right side – facial recognition
- left side – shapes/object recognition, reading
Cerebellum

- “small brain”
- Posture
- Balance
- Coordination
Brain Stem

- responsible for basic life functions:
  - Breathing
  - heart rate
  - body temperature
Dorsal & Ventral “pathways”
Ventral Stream

Temporal Lobe

Occipital Lobe
Ventral Stream – “What is it?”

Recognition of objects

Occipital lobes
- Receive visual input (primary visual pathway)

Temporal lobes – input from occipital lobes
- Visual “library”
- Words, numbers, shapes, landmarks
- Faces
- Color
Apple!
Dorsal Stream

- Motor Cortex
- Posterior Parietal
- Occipital Lobe
- Frontal Cortex

- Dorsal Stream
- Occipital Lobe
- Posterior Parietal
- Motor Cortex
- Frontal Cortex
Dorsal Stream - “Where is it?”

Vision for action - visual attention, visually guided movement

• **Occipital - posterior parietal lobes**
  – Integration of sensory input with attention and during **motor output**, management of visual complexity

• **Feedback from frontal cortices**
  – Motor planning, head/eye movement, visual guidance of movement
I want it

Attend, Attend

Fixate with Eyes

Reach

I want it
How do I move?

Where do I look???

?????

Too Much Information! !!!!!!!!
Apple!

I want it

It’s in front of me

Reach with right hand

I want it

Apple!
How do I move?

Where do I look???

Too Much Information!

!!!!!!!

??????
Brain Damage

Injury at Pre-term or Full-term (infants)

vs

Traumatic Brain Injury or Acquired damage (disease)
History of CVI

1900’s

WW I Veterans – posterior parietal lobe damage (visual field loss, decreased object avoidance, poor visually guided movement, poor eye movement, simultagnosia) Rudolph Balint & Holms

Early 1980’s

Cortical Blindness (occipital lobe damage)

Late 1980’s

Cortical Visual Impairment (post-chiasm to occipital lobe = reduced visual acuity)

* Does not include post-occipital lobe damage
History of CVI

1990’s
Increased knowledge of post-occipital lobe vision loss (Visual field loss, ocular motor, visual perception)

Cerebral Visual Impairment

2000’s
Increase in premature births (worldwide)
Survival rate (2010) 14:15 million
Increased prevalence of CVI (developed countries)
10 - 22: 10,000 under age 16
Increased professional awareness
Visual Impairment –

“visual impairment, including blindness, means an impairment in vision that, even with correction, adversely affects a child’s educational performance. The term includes for partial sight and blindness”

(IDEA, 2004 P.L. 108-446)
Terminology

Cortical Visual Impairment—
“Visual impairment related to the cortical area of the brain and/or optic radiations”

Cortical Visual Impairment

Characteristics

- Light gazing or withdrawal
- Better visual attention for:
  - Moving vs. static objects
  - Familiar vs. novel objects
  - Simple vs. complex environments
- Difficulty integrating gaze with reach
- Difficulty integrating looking with listening
- Poor social gaze
- Delayed visual (& other) responses
Terminology

Cerebral Visual Impairment –
“Visual malfunction due to retro-chiasmal visual and visual association pathway pathology”

Philip & Dutton (2014) Clinical and Experimental Optometry
Cerebral Visual Impairment

Characteristics

– Post optic chiasm brain damage
– Complex brain processing difficulties
– Dorsal/ventral stream dysfunctions
– May not be “legally blind”
Classification of Vision Loss

• **Ocular**
  – Eye structures, to chiasm

• **Ocular motor**
  – Brain stem, basal ganglia, thalamus, cerebellum

• **Cortical**
  – Primary pathway (post-chiasm to occipital)

• **Cerebral**
  – Post-chiasm, complex brain processing areas
Cerebral Visual Impairment Continuum

Profound Cortical Visual Impairment
Minimal Functional Vision

Visual Impairment
“Higher Order Visual Processing Dysfunction”
Patient M. **Cerebral + Ocular & OM VI**

- Premature birth (28 weeks gestation)
- Age 2 months: oxygen deprivation
  - Changes in occipital cortex
- Mild spastic diplegia
- Learning disabilities
Ocular Hx

- Cerebral Vision Impairment (Dx @ 8 months)
- Nystagmus
- Strabismus surgery for esotropia ~age 2
- Optic nerve pallor
- Glasses for hyperopic astigmatism
Patient M. Cerebral + Ocular & OM VI

Bilateral inferior field defect
### Ocular Findings

#### Distance Visual Acuity

<table>
<thead>
<tr>
<th>Right eye</th>
<th>Left eye</th>
<th>Both eyes</th>
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<tbody>
<tr>
<td>20/80+2</td>
<td>20/150</td>
<td>20/60</td>
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</tbody>
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#### Near Visual Acuity

<table>
<thead>
<tr>
<th>OU</th>
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<tbody>
<tr>
<td>1.0M @ 40cm (isolated line)</td>
</tr>
<tr>
<td>5.0M @ 25cm (whole chart)</td>
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</tbody>
</table>
Patient M.  Observations

• Visual scanning?

• Integration of visual & add sensory input?

• Vision for action?
Patient M.  Impressions

How to best characterize M’s visually guided behaviors?

- Cerebral Visual Impairment (Dorsal)
  - Impaired vision for action
  - Impaired attention
  - Impaired visually guided movement
  - Impaired vision for complex visual scenes (crowding)

- Ocular & OM Visual Impairment
  • Visual acuity deficit + strabismus do not account for behaviors
  • Eye turn & nystagmus does not account for level of functional vision
Patient M.  Recommendations

- **Collaborative approach**
  - TVI & AT
    - Modifications for learning
      - Enlarged print
      - Electronic technology
  - O&M
    - integrate tactile/auditory information for travel (multi-sensory approach)
    - Sequential instruction (repetition)
    - Contextual timing of tasks
Patient L: **Cerebral & Ocular VI**

**Medical Hx:**
- Prematurity (26 wks, 750 g)
- Bilateral hemorrhages
- Hypotonia of trunk & extremities
Ocular Hx

– Retinopathy of Prematurity (RE worse)
– Very high myopia & anisometropia (RE worse)
– RE amblyopia
  • Refractive and strabismic
Presenting concerns

Age: 18.5 years

• How much functional vision and how she uses it.
• Proficiency for driving?
• Symptoms:
  – Difficulty walking with changes in terrain/steps
  – Slow reaction time
  – Eyes ache and tire easily with demanding near tasks

• Eye Dr: VA & VF adequate for school work and driving
• Prior TVI/O&M evals: Services not needed
Patient L: Cerebral & Ocular VI

- Distance acuity with glasses
  - Both eyes viewing

<table>
<thead>
<tr>
<th>FULL CHART</th>
<th>ISOLATED LETTERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/60</td>
<td>20/40 -2</td>
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</tbody>
</table>

- Behaviors
  - Fatigued
    - Head/body posture and tone
    - Color
    - Voice
Patient L: Cerebral & Ocular VI

- Constricted Visual Fields – (nasal field more than temporal field)
Neuropsych eval
  – Normal IQ
  – Processing speed delays and anxiety

• Driving evaluation
  – Visual cognitive assessment in moving vehicle
    • Unable to manage & figure out what to do in complex situation (car tire blowout)
  – In a driving simulator had great difficulty planning and successfully implementing a lane change
Patient L  Cerebral VI vs. Ocular VI

• Driving evaluation
  – “She does not currently have the life skills necessary to cross a busy street, manage herself independently at home or in the community.”

• Based on this data and observations
  – Mother & daughter each completed a Dutton Inventory
  – MRI results requested
Patient L: Cerebral & Ocular VI

- Mild parietal – occipital area volume loss
- Asymmetrical ventricles
What other reported observations raised suspicions that there may be an additional basis for her visual impairment?

– Observation of use of vision during acuity testing

– Comments in recent OT driving evaluation
CLASSIFICATION OF VISUAL IMPAIRMENT BY CAUSE

Ocular
Ocular media, retina, optic nerve, to chiasm

Ocular Motor
Brain stem, cerebellum

Cerebral
post-chiasm
Patient L: **Summary**

- Decreased visual acuity
- Constricted visual fields
- Not “legally blind”
- Patient and mother report functional difficulties
- Processing delays and anxiety
- Does not possess safe travel skills
- MRI shows damage (occipital, parietal, ventricles)
Patient L: **Conclusions**

- Ocular VI is **NOT** the primary cause of L.’s visual function deficits
- Ed. team and eye doc. **DID NOT** identify signs consistent with Cerebral VI
- MRI + exam observations + Dutton Inventory support Dx of Cerebral VI (dorsal + ventral)
Collaborative Approach

- Stat eval by TVI and O&M specialist
  - FVA, LMA, O&M, AT
- Coordinate transition to community college or to the community in general
Where Are We Today?

1. Cerebral VI is a continuum

2. Cerebral VI can co-exist with Ocular dysfunction

3. Cerebral VI is #1 cause of pediatric vision loss in developed countries

4. No universally accepted term(s)
5. Identification/diagnosis of profoundly impaired children continues to be challenging

6. Methodology of assessing vision function can dramatically impact result

7. The physical environment directly impacts functional use of vision
Where Are We Today?

8. Entitlement to vision-related services is contingent on visual acuity/visual field (legal blindness)

9. Education & Rehabilitation instructional strategies have yet to be fully developed and scientifically proven.
Where Are We Today?

10. Additional training is needed by all team members!


About Brain Injury [www.waiting.com/brainanatomy.html#anchor2884157](http://www.waiting.com/brainanatomy.html#anchor2884157)


Resources and Images


Cortical/Cerebral Visual Impairment

What is it?

Kranb@necoe.edu

Darick.Wright@Perkins.org