Cortical/Cerebral Visual Impairment

Is it one or several or entities?
Can it co-exist with ocular impairments?

SESSION ONE

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Webinar Objectives

- Increase understanding of the diversity of signs and symptoms of vision impairment secondary to pediatric brain damage/maldevelopment

- Understand the difference between brain-related or non-brain related classifications of vision loss
What is What?

“What about a premie with some ROP, but not blinding, and maybe a little brain injury but not a devastated brain?”

“Some TVI’s say it is really important for them to know if a child’s poor vision is due to the brain or the eye (retina) because they would teach them differently”

Comment by Pediatric Ophthalmologist
From 24 wks to term, each cortical neuron establishes ~1000 synaptic connections.

– *In the last trimester, several hundred million synapses are created every minute!*

Preterm brain injury

- Focal & generalized white matter abnormalities (PVL)
  - Impaired cortical folding, reduced grey and white matter volumes
  - Reduced growth and development of posterior corpus callosum and its connections

http://neonatology.ucsf.edu/specialized-care/cerebral-palsy.aspx
Accessed 9 July 2010
Pediatric Brain Damage and Visual Impairment

Preterm infants are at risk for:

- Cerebral palsy
- Poor gross & fine motor skills
- Poor adaptive functioning
- Lower intelligence quotient
- Behavioral & emotional problems
- Asthma
- Visual pathway abnormalities (e.g.; ROP, myopia, strabismus)
- Cortical/Cerebral VI

Hypoxic ischemic encephalopathy (HIE)

- Diffuse brain damage
  - cerebral cortex, thalamus and brainstem
- Problems with motor control, cognition, emotions, learning
- Cortical/Cerebral VI

Pediatric Brain Damage and Visual Impairment

Brain injury at **Full term** is different than injury at **Preterm**
Primary Visual Pathway

Ocular structures

Optic tracts to the LGN and on to the primary visual cortex

Accessed 11 July 2010
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-occipital, complex brain processing areas
CLASSIFICATION OF VISUAL IMPAIRMENT BY CAUSE

**Ocular**
Ocular media, retina, optic nerve, to chiasm

**Cortical**
post-chiasm to V1 (striate or occipital)

**Ocular Motor**
Brain stem, cerebellum

**Cerebral**
post-V1
(parietal, temporal lobes, motor cortices & frontal lobes)

DL Mayer
2.28.10
Ocular Vision Impairment

Pre-chiasmal visual pathway

Eyes, retina, optic nerves

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

Diagnostic examples:

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

*Brain related visual difficulties may co-occur
CLASSIFICATION OF VISUAL IMPAIRMENT BY CAUSE

- **Ocular**
  Ocular media, retina, optic nerve, to chiasm

- **Cerebral**
  Post-V1
  (parietal, temporal lobes, motor cortices & frontal lobes)

- **Cortical**
  Post-chiasm to V1
  (striate or occipital)

- **Ocular Motor**
  Brain stem, cerebellum

*DL Mayer 2.28.10*
Ocular Motor Vision Impairment

May need to be differentiated from visual field loss, or CVI

Nystagmus
- “Nulling” head-eye positions
- Convergence null

Ocular Motor Apraxia (OMA)
- Lack of horizontal saccades
- Head thrusts to move eyes to target, overshoot and correction to fixate
CLASSIFICATION OF VISUAL IMPAIRMENT BY CAUSE

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  Ocular media, retina, optic nerve, to chiasm

- **Cortical**
  post-chiasm to V1 (striate or occipital)

- **Cerebral**
  post-V1
  (parietal, temporal lobes, motor cortices & frontal lobes)

- **Ocular Motor**
  Brain stem, cerebellum

DL Mayer
2.28.10
Cerebrum

Cerebrum

Cortical Visual Impairment

Characteristics

• Post chiasmal to occipital lobe damage
  – 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

• Dr. Christine Roman-Lantzy
CLASSIFICATION OF VISUAL IMPAIRMENT BY CAUSE

Ocular
Ocular media, retina, optic nerve, to chiasm

Cerebral
post-V1
(parietal, temporal lobes, motor cortices & frontal lobes)

Cortical
post-chiasm to V1
(striate or occipital)

Ocular Motor
Brain stem, cerebellum
Cerebrum

Cerebral Visual Impairment

Characteristics

• Post occipital lobe brain damage
  – Complex brain processing difficulties
  – Dorsal/ventral stream dysfunctions

• Prof. Gordon Dutton

• Dr. August Colenbrander calls “Cognitive dysfunction”
Dorsal & Ventral “pathways”
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
Ventral Stream

- Temporal Lobe
- Occipital Lobe
Apple!
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
I want it

It’s in front of me

Reach with right hand

Apple!
How do I move?
Where do I look???
?????

Too Much Information! !!!!!!!!
Summary

• Brain damage that occurs pre-term is different than damage that occurs with full-term babies.

• Vision Loss can be classified based on location within the brain and visual pathway as:
  – Ocular
  – Ocular Motor
  – Cortical
  – Cerebral
Visual Sequelae of Pediatric Brain Damage

A complex combination of abnormal visual behaviors due to brain damage, with probable subcategories that can co-exist with ocular & ocular-motor categories.
Summary

- Historically, many have defined Cortical Vision Impairment as being associated only with the visual pathway and occipital lobe.

- Cerebral Vision Impairment involves other portions of the brain that are required for visual function.
  - Dr. Gordon Dutton’s - impact of damage to the Dorsal and Ventral Streams on visual function.
Images & Resources

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


Kran BS, Mayer DL. Chapter 14 Vision impairment and brain damage in Taub, Bartuccio, Maino eds Visual diagnosis and care of the patient with special needs. Lippincott 2012


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