Cortical/Cerebral Visual Impairment

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

SESSION TWO

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In this webinar...

• Briefly review classification of pediatric brain related vision loss

• 4 Case Examples
  – Cortical VI
  – Cerebral VI – Ventral
  – Cerebral VI – Dorsal + Ocular + Ocular Motor
  – Cerebral VI – Dorsal - Ventral
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
Pediatric Brain Damage and Vision Impairment

Causes of pediatric brain damage

- Encephalopathy
- Maldevelopment
- Trauma – accidental and non-accidental
- Seizures
- Neurodegenerative disorders
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
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
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**: Cortical post-chiasm to V1 (striate or occipital)
- **Ocular Motor**: Brain stem, cerebellum

DL Mayer 2.28.10
Patient A.  

Cortical VI

Age: 5.5 yrs

Medical Hx

– Neonatal sepsis
– Infantile spasms
– Severe cerebral atrophy
– Global delays
Visual Function

• **Visual acuity** (glasses, both eyes viewing)
  • “20/360” for TAC gratings
    • Individualized presentation

• **Visual field**
  • Severely impaired
  • Suspect small area of far peripheral field remaining
Patient A. **Observations**

- Eye/head position?
- Use of senses?
- How is task completed?
- Need for prompting?
Patient A.  Conclusions

Profound Cortical VI

- Tactile exploration of objects
- Limited visually guided behavior
- Not discriminating objects & people by sight
- Some auditory & tactual discrimination

Collaborative approach to education

- Roman CVI Scale
Cortical Visual Impairment

Post chiasmal to occipital lobe damage
- Severely reduced VA and Contrast Sensitivity + VF defects

• 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

• Dr. Christine Roman-Lantzy
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Ocular Motor
Brain stem, cerebellum
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 visual dysfunction”
Dorsal & Ventral “pathways”
The Tree of Vision

Central visual processing to serve:
- Conscious recognition
- Search, attention & guidance of movement

Recognizing people
Recognizing facial expressions

Finding a person in a group of people

Spotting a distant target
Finding clothes in a pile
Finding objects in clutter
Finding an object on a patterned background
Crowding of text

Visual guidance of movement of the
arms and hands
legs and feet
body

Right
Left

Temporal lobes

Temporal Stream
Central Stream

Occipital lobes
Clarity / Acuity
Color vision
Contrast sensitivity
Optic radiations
Visual fields
Lateral geniculate bodies

Posterior parietal lobes
Middle temporal lobes (MT)
for the accurate perception of movement
Reflex vision in the upper mid-brain (Superior colliculi)

Optic tracts
Optic chiasm
Optic nerves
Retina

Left eye
Right eye

Visual Scene
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
Pt. C. Ventral stream dysfunction

Age 10 years

Medical- neurological Hx
- Non-accidental trauma at age 3.5 months
- MRI – severe damage to visual cortex and association areas
- Cerebral palsy – left side worse; non-ambulatory

Ocular Hx
- Retinal hemorrhages, resolved
- Nystagmus
- Exotropia
- Optic nerves – temporal pallor
- Myopic astigmatism
Pt. C  Ventral stream dysfunction

Visual acuity, both eyes, glasses
- “20/100” grating acuity
- Discrepancy with symbol acuity
  - Shapes – 2” height at 3-4”
    - matches better than names
  - Letters – 2” height at 3” distance

Visual field
- Generalized constriction, more on left
Pt. C  Ventral stream dysfunction

Visual recognition

- Requires long term practice to identify pictures & letters
- No recognition of transformed familiar object
- Uses color to identify Mayer-Johnson icons (not B&W)
- No recognition of familiar people by sight
Pt. C  **Ventral stream dysfunction**

**Dorsal Stream Functions Intact**

- Visual motor – looks & reaches accurately for small objects, points to images
- Spatial relationships – good
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Ocular Motor
Brain stem, cerebellum

DL Mayer
2.28.10
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
Patient M. **Cerebral + Ocular + OM**

Medical Hx

- Premature birth (28 weeks gestation)
- Age 2 months: oxygen deprivation
  - Changes in occipital cortex on MRI and EEG
- 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*
Ocular Findings

Distance Visual Acuity (both eyes)
- 20/70 (isolated line)
- 20/150 (whole chart)

Near Visual Acuity (both eyes)
- 1.0M @ 40cm (isolated line)
- 5.0M @ 25cm (whole chart)
Patient M. Cerebral + Ocular + OM

Bilateral inferior field defect
Patient M.  Observations

- Visual scanning?
- Integration of visual & add sensory input?
- Vision for action?
Patient M. Cerebral + Ocular + OM

Cerebral Visual Impairment (Dorsal)

- Impaired vision for action
- Impaired attention
- Impaired visually guided movement
  - Rarely looks down as he walks, esp. on stairs
  - Misses objects close to him while seated
  - Documented *inferior* visual field loss
  - Suspected inferior field neglect
- Impaired vision for complex visual scenes (crowding)
- Visual acuity deficit + strabismus do not account for behaviors
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Ocular Motor
Brain stem, cerebellum
Patient L: Cerebral & Ocular VI

Medical Hx:

– Prematurity (26 wks, 750 g)
– Bilateral germinal matrix hemorrhages
– Ventriculomegaly (greater on right)
– Hypotonia of trunk & extremities
Ocular Hx

– ROP (RE worse) – treated surgically

– Very high myopia & anisometropia (RE worse)
  • Staphylomata

– RE amblyopia
  • refractive and strabismic
• Distance acuity with glasses
  – Both eyes viewing:
    • 20/60 full chart
    • 20/40-2 isolated letters
      – (RE: 20/150-)
  • ~12-15 minutes to complete
– Behaviors
  • Patient was clearly fatigued
    – Head/body posture and tone
    – Color
    – Voice
Neuropsych eval
- Normal IQ
- Processing speed delays and anxiety

• Driving evaluation (OT)
  - 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

  “She does not currently have the life skills necessary to cross a busy street, manage herself independently at home or in the community. This suggests that she may have a performance based learning disability.”
Dutton CVI Inventory - DORSAL

**Mother & L scored “always” or “often” on DORSAL items:**

- Visual field/visual attention when moving
- Impaired visually guided movements
- Impaired perception of movement
- Difficulty with complex visual scenes
- Difficulty in crowded environments
- Impaired visual attention
Dutton Inventory - VENTRAL
Visual Recognition

– Mother and daughter disagreed on 6/7

– L. reported an inability to recognize close relatives in real life and in photos, and confuses strangers for familiar people.

*Does this mean that daughter compensates for ventral problem without Mother’s awareness?*
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)
Summary

Visual Sequelae of Pediatric Brain Damage

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

Approach to care and education is emerging.
  – Diagnosis and management require a collaborative approach. (medical & educational)

Eye care providers need additional tools & training to identify Cortical & Cerebral VI

Individuals with Cerebral VI may not have access to vision-related services
  – TVI, O&M may not be most appropriate to assume primary responsibility for ed plan.

TVI, O&M have significant and necessary contributions to development of ed plan.
Summary

Future Directions

– Recognition of the diversity of patients with visual impairment secondary to brain damage by medical & educational communities

– Develop an agreed upon classification scheme

– Determine appropriate testing and instructional methods to meet the needs of individual students

– Expand training of all vision educators, medical and related service providers
Resources


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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