Binocular Vision Made Easy: A Practical Approach to the Diagnosis and Management of Binocular Vision Disorders

Erin C Jenewein, OD, MS, FAAO
Nova Southeastern University
jenewein@nova.edu

Why is it important to diagnose binocular vision problems?

- Prevalence
  - Much more common than ocular disease conditions in children
  - 8.5 times more common than ocular disease in patients ages 6-18


Why is it important to diagnose binocular vision problems?

- Impact of binocular vision problems in children
- Impact of binocular vision problems in adolescents
- Impact of binocular vision problems in adults

Chief Complaint

- Often BV problems have non-specific complaints
  - Blur at near
  - Asthenopia with near work
  - Diplopia
  - Headache
  - Eye strain
  - Avoidance of near work

Chief Complaint

- Patient complaints
- Parent complaints

Chief Complaint

- Sometimes the chief complaint is more specific, and can often help you diagnose the condition....
  - Diplopia at near, with words "moving around on the page"
  - Blur at distance after reading/near work
  - Diplopia at distance
Get the Details!!!

- How long has it occurred for?
- When do they notice symptoms?
- How often?
- Does anything relieve symptoms?
- Occur on the weekend?
- Do the symptoms subside as soon as near work stops?

Patient/Parent Symptom Questionnaires

Caution!! Neurological Signs and Symptoms....

- Headache***
- Diplopia
- ONH edema
- Clumsiness, ataxia, gait imbalance
- Nystagmus
- Nausea or vomiting
- Personality or behavior change
- Lethargy

Diagnosis: History

- Ocular History
- Systemic History
  - Birth
  - Development
- Family History

Diagnosis: Academic History

- Subject specific performance in school
- Learning problems
  - Tutoring or remediation
  - Repeated a grade?
- Behavioral problems
  - ADHD

What tests do we use???

- Distance CT
- Near CT
- NPC
- NRA/PRA/BCC
- AA/MEM
- Vergence Ranges
  - Smooth
  - Step
- Facility
  - Accommodative (MAF/BAF)
  - Vergence
Diagnosis: Accommodative Testing

• Monocular versus Binocular Testing

Diagnosis: Accommodative Testing

• Accommodative Amplitude Testing
  • Push Up/Pull Away
    • Advantages
    • Disadvantages
  • Minus Lens to Blur
    • Advantages
    • Disadvantages

Diagnosis: Accommodative Testing

• Calculating normative values
  • Average
    • 18.5 – 1/3 age
  • Minimum
    • 15 - 1/4 age

Diagnosis: Accommodative Testing

• Case Example

Diagnosis: Accommodative Testing

• Binocular Crossed Cylinder/Fused Crossed Cylinder
  • Expected Value
    • +0.50 (+/- 0.50)
  • Disadvantages
    • Difficult on young patients

Diagnosis: Accommodative Testing

• Negative Relative Accommodation
  • Expected Value: +2.00 (+/- 0.50)
  • Test of relaxation of accommodation
  • Indirect test of positive fusional vergence
Diagnosis: Accommodative Testing

- Positive Relative Accommodation
  - Expected Values: -2.37 (+/-1.00)
  - Test of stimulation of accommodation
  - Indirect test of negative fusional vergence

Diagnosis: Accommodative Testing

- Monocular Estimation Method
  - Objective test
  - Accuracy of accommodation
  - Expected values: plano -0.75

Diagnosis: Accommodative Testing

- Accommodative Facility Testing
  - Monocular
    - +/- 2.00 flippers
    - 8 – 12 years old – 7 rpm
    - Over 12 – 11 rpm
  - Binocular
    - +/- 2.00 flippers
    - Suppression check
    - 8-12 years old – 5rpm
    - Adults – 10rpm

Diagnosis: Vergence Testing

- Smooth Vergence Testing – Vergence Amplitude
  - Blur
    - Fusional Vergence without Accommodation
  - Break
    - Fusional and Accommodative Vergence
  - Recovery

Diagnosis: Vergence Testing

- Smooth Vergence Ranges
  - Negative Fusional Vergence (BI)
    - Norms
      - Distance: x/7/4
      - Near – 3/21/11
    - Indirectly testing positive relative accommodation

Diagnosis: Vergence Testing

- Smooth Vergence Ranges
  - Positive Fusional Vergence (BO)
    - Norms
      - Distance: 5/19/10
      - Near – 7/21/11
    - Indirectly testing negative relative accommodation
Diagnosis: Vergence Testing

- Step Vergence Ranges
  - Advantages
    - Outside the phoropter
  - Objective test

Diagnosis: Vergence Testing

- Vergence Facility
  - Different from amplitude testing
  - 3 BI / 12 BD
  - Vertical row of letters
  - Norm
    - 15 cpm

Diagnosis: Vergence Testing

- Near Point of Convergence
  - Target Selection
    - Accommodative target
    - Penlight
    - Penlight with R/G glasses
  - Repetition of test

Diagnosis: Vergence Testing

- Near Point of Convergence
  - Expected Values
    - Accommodative Target
      - 5cm/7cm
    - Penlight and R/G glasses
      - 7cm/10cm

Treatment: Will Lenses Help?

- First step: good manifest prescription
  - Dry retinoscopy
  - Cycloplegic retinoscopy

How do I know if plus will help???

- Is your patient a plus acceptor??
  - Lag on MEM/BCC
  - High NRA, Low PRA
  - Falls (-) on MAF/BAF
  - Eso at near
  - Low AA
How to Determine Near Plus Rx?

- For Convergence Excess
  - Lenses that provide desired alignment (eso reduced or eliminated at near)
- For Al or Pseudo CI
  - Lenses that produce normal lag on MEM
  - Normal lag on MEM: +0.25 to +0.75D
- Balance NRA/PRA??

Treatment: Will Plus Lenses Help?

- Prescribing plus for near
  - Taking myopic glasses off for near work
  - NVDs
  - Bifocals
  - PALs

Treatment: Will Minus Lenses Help?

- When to consider added minus lenses for your patient
  - Esophoria/Exotropia
  - Divergence Excess
  - High CA/C ratio
  - Young patients

Treatment: Will Minus Lenses Help?

- Prescribing overminus lenses
  - Methods of prescribing
  - Add at near?

Treatment: Will Minus Lenses Help?

- Case example

Treatment: Will Prism Help?

- Indications for prism
  - Vertical deviation
  - Intermittent strabismus
  - Large heterophoria
Treatment: Will Prism Help?

• Prescribing Prism
  • Dissociated Prism Criteria
  • Associated Prism Criteria

Treatment: Will Prism Help?

• Dissociated Prism Criteria
  • Percentage Criteria
    • Percentage of the total dissociated deviation given
    • May be 1/3 to as high as 2/3

Treatment: Will Prism Help?

• Dissociated Prism Criteria
  • Residual Vergence Demand

- Type of Deviation
- Size of Deviation
- Residual Vergence Demand

<table>
<thead>
<tr>
<th>Type of Deviation</th>
<th>Size of Deviation</th>
<th>Residual Vergence Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esodeviation</td>
<td>6 – 20 prism diopters</td>
<td>4 – 6 prism diopters</td>
</tr>
<tr>
<td>Exodeviation</td>
<td>20–30 prism diopters</td>
<td>10–15 prism diopters</td>
</tr>
<tr>
<td>Hyperdeviation</td>
<td>3–10 prism diopters</td>
<td>2–4 prism diopters</td>
</tr>
</tbody>
</table>

Calhoun and Rose, *Clinical Management of Strabismus*, 1993

Treatment: Will Prism Help?

• Associated Prism Criteria
  • Fusion prism
    • Sheard’s Criteria
      • Amount of prism = 2/3 phoria – 1/3 compensating fusional vergence
  • Percival’s Criteria
    • Amount of prism = 1/3 Greater lateral limit – 2/3 Lesser lateral limit
  • Fixation Disparity

Accommodative Conditions

• Accommodative Insufficiency
  • Common symptoms: Near blur/asthenopia
  • Clinical signs
    • Low PRA
    • Large lag of accommodation
    • Low NRV
    • Difficulty with ( ) on MAF/BAF
    • Low amplitude of accommodation

Accommodative Conditions

• Accommodative Insufficiency
  • Management
    • Lenses
    • Vision Therapy
Accommodative Conditions

• Accommodative Excess
  • Symptoms: Asthenopia/Blur at near
  • Signs:
    • Lead on MEM/BCC
    • Low NRA
    • Difficulty with plus on MAF/BAF
    • Low PFV

• Accommodative Infacility
  • Symptoms: Blurred vision when looking from distance to near and near to distance, near asthenopia
  • Clinical signs:
    • Low NRA/PRA
    • Low MAF/BAF
    • May have low NFV/PFV

Accommodative Conditions

• Accommodative Excess
  • Treatment
    • Vision therapy

Accommodative Conditions

• Accommodative Infacility
  • Management
    • Vision therapy
    • Near lenses???

Vergence Conditions

• Convergence Insufficiency
  • Symptoms: Near asthenopia, diplopia, words moving on the page, poor attention or concentration
  • Clinical Signs:
    • Exo > near than distance
    • Reverted NPC break
    • Inadequate PFV ranges at near
    • Lead on MEM/BCC
    • Low NRA ranges
    • Fals (+) on BAF

Vergence Conditions

• Convergence Insufficiency Symptom Survey
Vergence Conditions

• Convergence Insufficiency
  • Management
    • Office based vision therapy

Vergence Conditions

• Convergence Excess
  • Symptoms: Blurry vision, diplopia, asthenopia at near
  • Clinical Findings
    • Eso at near > Eso at distance
    • Low NFV at near
    • Low PRA
    • Fail BAF with (-)
    • High lag on MEM or BCC

Vergence Conditions

• Divergence Insufficiency
  • Symptoms: Diplopia at distance
  • Clinical Signs:
    • Eso D > N
    • Decreased NFV at distance

Vergence Conditions

• Pseudo Convergence Insufficiency
  • Truly an AI
  • (+) Acceptor
  • AI with a near XP
  • Lag on MEM/BCC
  • Low AA
  • (+) for near will improve NPC

Vergence Conditions

• Convergence Excess
  • Management
    • Plus at near
    • VT

Vergence Conditions

• Divergence Insufficiency
  • Management
    • Prism
    • Vision Therapy
Vergence Conditions

• Divergence Excess
  • Symptoms:
    • May have diplopia at distance
    • Closes one eye in bright light
  • Clinical Signs:
    • Exo D > N
    • May have normal PFV ranges
    • Normal NPC

Vergence Conditions

• Real versus Simulated DE
  • Occlusion test
  • +3.00 test

Vergence Conditions

• Basic Esophoria
  • Symptoms:
    • May present at both distance and near
  • Clinical Signs:
    • Esophoria D = N
    • Low NFV D & N
    • Low NRA
    • High lag on MEM
    • Difficulty with (-) lenses on BAF

Vergence Conditions

• Basic Esophoria
  • Treatment
    • Correct any hyperopia
    • Near addition lenses if indicated
    • Prism
    • Vision Therapy

Vergence Conditions

• Basic Exophoria
  • Symptoms
    • May occur at distance and near
  • Clinical Signs
    • Exophoria D = N
    • Low PFV
    • Low NRA
    • Receded NPC
    • MEM – lower lag or lead
Vergence Conditions

- Fusional Vergence Dysfunction
  - Symptoms
  - Near asthenopia, eye strain, headache, blurry vision
  - Clinical findings
  - D and N phoria normal
  - Low NRA/PRA
  - Low PFV/NFV
  - Fails BAF
  - Low vergence facility (BI and BO)

Vergence Conditions

- Fusional Vergence Dysfunction
  - Management
    - Vision Therapy
    - Vergence amplitudes
    - Vergence facility

Amblyopia

Unilateral or bilateral condition
- BCVA is poorer than 20/20
- No structural or pathologic anomalies
- One or more of the following conditions occurring before 6-8 years of age:
  - Significant refractive error
  - Constant, unilateral strabismus
  - Form vision deprivation

What is **Significant** Refractive Error?

<table>
<thead>
<tr>
<th></th>
<th>Isoametropic</th>
<th>Anisometropic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astigmatism</td>
<td>≥2.50D</td>
<td>≥1.50D</td>
</tr>
<tr>
<td>Myopia</td>
<td>≥6.0D</td>
<td>≥3.0D</td>
</tr>
<tr>
<td>Hyperopia</td>
<td>≥4.0D</td>
<td>≥1.0D</td>
</tr>
</tbody>
</table>

**Tarczy-Hornoch et al. (2013) Ophthalmology. 120:1220-1226.**

Strabismus

- Early onset
- Constant
- Unilateral
- More commonly ET

Form Deprivation

- 0.1% of the general population*
- Severe amblyopia
- Obstruction of the line of sight
  - Prolonged blepharospasm/ptosis
  - Corneal opacity
  - Hyphema
  - Cataract
  - Vitreous opacity

**Friedman, D.S., et al. (2009) Ophthalmology. 66 (11) 2128-2134.**
Is It Really Amblyopia???

- Amblyogenic factor must be present
- Must rule-out any underlying ocular or neurological pathology that may explain a decrease in VA
- Ocular pathology may co-exist with amblyopia

Normal Findings in Patients with Amblyopia

- Pupils
- Amsler Grid
- Visual Field
- Color Vision

★ If any of these are abnormal, carefully consider your diagnosis!!!!! ★

Amblyopia

• Management
  - Spectacle Correction
    - Important first line of treatment for amblyopia
  - Cycloplegic retinoscopy/refraction
  - Should I cut the Rx?

Amblyopia

• Spectacle Correction
  - Resolves strabismic and strabismic/aniso amblyopia in 25% of children 3 - 7*
  - Most bilateral amblyopia resolves within 1 year of correction**
  - Resolves aniso amblyopia in 1/3 of children 3 - 7***
  - In older children (7-17 yrs) amblyopia improves in 25% of patients with correction alone****


Amblyopia

• Management
  - Patching regimens

Vision Therapy Basics

• Improve accommodative amplitude and stimulation of accommodation
  - Lens sorting
  - Near/Far Hart Chart
  - Monocular Slit Lense Accommodative Rock
• Improve Smooth Positive and Negative Fusional Vergence Amplitudes
  - Vestigrams
  - Brock String
  - Tranaglyphs
  - Computer RDS therapy
Vision Therapy Basics

- Improve Ability to Stimulate and Relax Accommodation Efficiently
  - Monocular Accommodative Rock
  - Red Red Rock
  - Binocular Accommodative Rock
- Improve Positive and Negative Fusional Vergence Facility
  - Aperture Rule
  - Vectograms
  - Tranaglyphs

Vision Therapy Basics

- Integrate accommodative changes in vergence therapy
  - Lenses to change accommodative demand with vergence therapy
  - Improve Vergence facility (Change from convergence to divergence)
  - Aperture Rule(s)
  - BI/BO Vectograms
  - Eccentric circles
- Vergence integrated with versions and saccades
  - Eccentric circles
  - Brock string
  - Lifesaver Cards