Update on Amblyopia Management

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Disclosure Statement:
Nothing to disclose
Course objectives

- Review diagnostic techniques for differentiating amblyopia types, including amblyopia associated with microstrabismus
- Review evidence-based treatment with refractive correction and occlusion
- Explain the rationale for and use of active vision therapy procedures for:
  - Eccentric fixation
  - Oculomotor skills
  - Eye-hand coordination
  - Pattern discrimination
  - Accommodation
  - Suppression/Binocularity
Diagnosis

- History
  - Systemic/ocular health
- Best corrected visual acuity – crowding bars
- Refraction – cycloplegic
- Ocular health

Photo: Arch Ophthalmol 2001;119(9):1345-1353. doi:10.1001/archopht.119.9.1345 Copyright © 2012 American Medical Association. All rights reserved.
Diagnosis

- Rule out eccentric fixation and (micro)strabismus
  - Monocular fixation
    - Visuoscropy
  - Binocular status
    - Cover test – control fixation well!
    - Stereopsis
    - Worth 4-dot
Microstrabismus characteristics

- Strabismus of up to 10Δ (constant)
- ET most common
- Primary or post-surgical
- Amblyopia in strabismic eye
- Reduced stereopsis
- Central suppression
- Anomalous correspondence (AC), typically harmonious type
- Eccentric fixation common

**Visuoscopy technique**

- Insure patient understands task
- Occlude eye not being tested!
- Dim the direct ophthalmoscope light – insure patient can see target
- Hold grid with straight lines at 90° and 180°
- Evaluate steadiness as well as magnitude and direction
- Confirm by moving target slightly; ask patient to refixate
- Estimate VA: $\text{MAR} = \text{EF (in } \Delta) + 1$
Stereopsis testing

- Random dot preferred over lateral disparity for identification of strabismus
- Make sure children understand the task but don’t cheat!

Randot® Preschool Stereotest
http://www.stereooptical.com/shop/stereotests/randot-preschool-stereotest/
Worth 4-dot

- If 4 dots seen and patient has constant strabismus, check UCT – possible anomalous correspondence
- Test at 40 cm, intermediate, and far
- Suppression is foveal if present only at distance
- Suppression is deep if present in bright and dim room

<table>
<thead>
<tr>
<th>Test distance</th>
<th>Subtends (degrees)</th>
<th>(Δ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 inches</td>
<td>4.5</td>
<td>7.8</td>
</tr>
<tr>
<td>3 feet</td>
<td>2</td>
<td>3.5</td>
</tr>
<tr>
<td>6 feet</td>
<td>1</td>
<td>1.75</td>
</tr>
<tr>
<td>10 feet</td>
<td>0.6</td>
<td>1</td>
</tr>
<tr>
<td>20 feet</td>
<td>0.3</td>
<td>0.5</td>
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Types of amblyopia

- Isoametropic – active vision therapy less often needed
- Anisometropic
  - Hyperopic
  - Myopic
- Strabismic
  - Central fixation
  - Eccentric fixation – unsteady versus steady
- Form deprivation
Optimum refractive correction

- Full (cycloplegic) correction often appropriate
  - Full-time wear important (Polycarbonate)

- If plus must be cut, do so equally OU
  - Generally cut by no more than 1.50 D.

- Consider CLs for >2-3 D. anisometropia

- Follow at 1-2 month intervals till maximal improvement before any other treatment
Results with refractive correction alone

- **Bilateral refractive amblyopia**
  - 74% of children (ages 3-<10) reached >20/25 within 1 year

- **Anisometropic amblyopia**
  - 27% of cases (ages 3-<7) resolved (w/in 1 line)
  - Much better success when initial VA >20/100
  - Mean improvement ~3 logMAR lines (took up to 30 weeks)
    (PEDIG, *Ophthalmology* 2006;113:895-903)

- **Strabismic amblyopia**
  - 32% of cases (ages 3-<7) resolved (w/in 1 line)
  - Mean improvement ~3 logMAR lines
    (PEDIG, *Ophthalmology* 2012; 119:150-158)
Most (>90%) achieved best VA by 18 weeks

*(Ophthalmology 2012;119:150–158)*
Results with direct occlusion

- 2 hours/day – initial VA 20/40-20/80
  - 62% of children (ages 3-7) improved to >20/32 or >3 lines within 4 months
  - Mean improvement 2.4 lines in 4 months
    (PEDIG, Arch Ophthalmol 2003; 121:603-11)

- 6 hours/day – initial VA 20/100-20/400
  - Mean improvement 4.8 lines in 4 months
    (PEDIG, Ophthalmology 2003; 110:2075-87)
Increasing occlusion time

- Subjects: children (ages 3-7) with stable residual amblyopia after at least 12 weeks of patching (20/32 to 20/160)
- Randomized to continue patching 2 hours/day or increase to 6 hours/day
  - 2-hour patching group: 39% gained >2 lines, 35% had no improvement
  - 6-hour patching group: 51% gained >2 lines, 30% had no improvement

(PEDIG, Ophthalmology 2013; 120:2270-7)
Tapering patching program

- Reduce to 2 hr./day in children < 8 years old before stopping
  (PEDIG, J AAPOS 2004; 8:420-8)

- Children age 7-12 have 7% risk of decreasing VA after patching, as long as Rx wear continues
  (PEDIG, Arch Ophthalmol 2007; 125:655-9)
Bangerter filters

- Subjects: children ages 3-9 with 20/40 to 20/80 amblyopic VA
  - Bangerter group (full-time): 38% gained >3 lines in 24 weeks
  - Patching group (2-6 hr./day): 35% gained >3 lines in 24 weeks
    (PEDIG, *Ophthalmology* 2010; 117:998-1004)

- Filters reduce suppression and promote binocular vision in amblyopic patients with aligned eyes
  (Chen et al., *IOVS* 2015; 56:139-149)
Atropine penalization

- Minimal stinging
- Cheaper than bandage patches
- Atropine in dominant eye (1%, daily or twice/week)
- Encourages use of amblyopic eye
- Preferable for child to have moderate to high hyperopia versus myopia, with adequate VA in amblyopic eye
- Disadvantages: long-term blur, photophobia, side effects
  - Educate parents on need for hat/uv protection outdoors
Atropine penalization effectiveness

- For ages 3-6 with moderate amblyopia, atropine works as well as patching
  - Mean VA increase ~3 lines in 6 months
    (PEDIG, *Arch Ophthalmol* 2002; 120:268-78)
- For ages 7-12 with moderate amblyopia, atropine also works as well as patching
  - 17% achieved 20/25 or better after 17 weeks of atropine
    (PEDIG, *Arch Ophthalmol* 2008; 126:1634-1642)
Evidence-Based, Step-Wise Management Strategy for Amblyopia

Moderate amblyopia due to anisometropia and/or strabismus

Spectacle correction; F/U every 1-2 months until no further improvement

*If persists*, initiate additional treatment (2 hrs. daily patching, atropine, or Bangerter filter); F/U every 1-2 mos. until no further improvement

*If persists*, consider increasing patching from 2 to 6 hours daily. Follow every 1-2 months until no further improvement

When maximum VA reached, taper or stop treatment & monitor for amblyopia recurrence

(PEDIG, *Ophthalmology* 2013;120(11):2270-7)
Why active vision therapy?

- **Rationale**
  - Supplemental to patching – not all patients improve maximally with refractive correction & patching alone
  - Address patients who have regressed after patching stopped
  - Improve specific **skill deficiencies**

- PEDIG: evaluated common near versus distance activities, along with 2 hours/day of patching, and found that both yielded ~2.5 lines **VA improvement** after 17 weeks
  
  (*Ophthalmology* 2008; 115:2071-8)
Skill deficiencies in amblyopic eyes

- Inaccurate monocular fixation\(^1, 2\) (eccentric or unsteady central)
  - Capable of improvement with Tx using auditory biofeedback\(^3\) or foveal tagging\(^4\)

- Increased saccadic latency\(^5, 6\)

- Inaccurate pursuits\(^7\)

1. Ciuffreda et al. *BJO* 1980; 64:7-14
2. Ciuffreda et al. *JAOA* 1979; 50: 1251-58
Skill deficiencies in amblyopic eyes

- Contour interaction\(^1\)
- Spatial distortion/positional uncertainty\(^2,3\)
- Reduced efficiency for processing orientation\(^4\)
- Reduced pattern perception (undersampling)\(^5\) and speed of visual information processing

2. Bedell et al., *IOVS* 1985; 26:909-16
Skill deficiencies in amblyopic eyes

- Reduced contrast sensitivity\(^1\)
- Increased contrast threshold for discriminating motion direction\(^2\)
- Eye-hand coordination
  - Reduced before treatment\(^3\)
  - Improvement after stereo and VA increase with treatment\(^3\)
  - Video game training (40 h) shown to improve VA, CSF, crowding\(^4\)

3. Grant et al., *IOVS* 2014; 55:5687–57015
Skill deficiencies in amblyopic eyes

- Accommodation – accuracy
  - Approx. 0.50 D greater lag in amblyopic eyes compared to fellow eyes

(Manh V, Chen A, Tarczy-Hornoch K, Cotter SA, Candy TR. IOVS 2015; 56:1193-1207)
Skill deficiencies in amblyopic eyes

- Reduced accommodative amplitude\(^1\)
  - Capable of improvement with therapy\(^2\)

- Increased accommodative reaction time, decreased sustainability\(^2\)

Skill deficiencies in amblyopic eyes

- Suppression/reduced binocularity
  - Interocular suppression (in strabismic > aniso amblyopia)\(^1\)
  - Games developed to address suppression\(^2\)

Types of vision therapy

- Much amblyopic VT is monocular, done during patching
  - Attempt to equalize skills in the two eyes
  - Recommend an hour/day at home, give variety
- Anti-suppression and binocular VT also important in many cases
  - Aniso and isoametropic amblyopia
  - Strabismic amblyopia – may or may not elect to treat strabismus
    - Prognosis
    - Patient motivation
Fixation therapy

- Improve accuracy & steadiness, then speed
  - Start w/ use of **proprioceptive feedback** (hand leading eye)
  - Later, eye should lead hand
  - Progress from **gross to fine** targets
  - Progress from **isolated to crowded targets**
Haidinger’s brushes (MITT) for EF treatment
Fast pointing for EF treatment

- **Quickly** move hand to target without watching hand
- Encourages foveal fixation
  - Can perform with MITT
  - Quickly insert pegs into pegboard
  - Insert stick or pipe cleaner into straw
  - Can spear food (then eat!)
  - Dot center of circles on paper with marker
    - Make them progressively smaller
    - Make it a game to engage interest
Pursuit therapy

- Progress from small to large pursuits
  - Rotators
  - Swinging ball
  - Computer programs:
    Sanet Vision Integrator, others
Saccade therapy

- Progress from gross to fine
- Monocular prism jumps
  - Prism inserted as patient fixates target
  - Watch eye for proper saccade
  - Vary base direction
  - Large to small powers – “just noticeable difference”
  - Add fast pointing at target
Saccade therapy

- Hart chart saccades
  - Column saccades (outer, then inner)
  - Oblique saccades
  - “Battleship” saccades
  - Add balance board or movement
- Letter tracking sheets
Figure-ground therapy

- Addresses contour interaction
  - Hidden pictures
  - Puzzles using pictures, numbers, or letters

Free printable puzzles:
www.puzzles.ca
Spatial localization/eye-hand coordination therapy

- Addresses:
  - Spatial uncertainty
  - Contour interaction
  - Eye-hand coordination
    - Pattern duplication, mazes, coloring, picking up small food, video games
Pattern/shape perception therapy

- Resolution of fine detail – addresses contrast sensitivity
  
  www.schoolsparks.com/kindergarten-worksheets/visual-discrimination
Pattern/shape perception therapy

- Addresses accuracy & speed of visual information processing
  - Tachistoscopic presentation of numbers or letters
  - Video games, including many for smart phones & tablets

http://www.bernell.com/category/267
Eye-hand coordination and pattern/shape perception therapy

- Amblyopia iNet:
  - “Space ball”
  - “Capture the target”
Pattern/shape perception therapy research

- Perceptual learning (PL) paradigms
  - Repetitive, challenging monocular trials with feedback
  - Use targets near VA threshold:
    - Position discrimination of Gabor patches
    - Vernier acuity
    - Letter identification in noise
  - Improves VA over patching alone;
    - fMRI shows increased activation of visual cortex by amblyopic eye (Zhai et al., BJO 2013; 97:1420-4)
  - PL reduces noise, improves efficiency of stimulus processing
    (Levi et al., Vision Res 2009; 49:2535–49)
Accommodative therapy (school-age and older patients)

- Generally start when VA is about 20/60
- Progress from large, simple targets to smaller & more crowded
- Progress from push-up (proximal) target to lens-induced blur
- Progress from gross to fine changes
- Emphasize accuracy, amplitude, speed, fine control

Examples:
- Monocular target push-ups
- Loose lens rock
- Flippers
Case Report 1

- 6 y.o. with strabismic amblyopia
  - CLET 10Δ
  - Aided VA 20/250 OS
  - Visuoscropy: 2-3Δ nasal, 1Δ superior unsteady EF OS
- Patched 5-6 hr./day along with VT:
  - Eye-hand coordination activities
  - Fast-pointing (could not appreciate Haidinger’s brushes)
  - Hidden pictures
Case Report 1, continued

- 4 months later reached 20/40 OS
  - EF <1Δ nasal and superior
- Added accommodation treatment
  - Several months later documented unsteady central fixation
  - No further increase in VA even with increased patching
Anti-suppression therapy

- Address inhibition of amblyopic eye by preferred eye
- Primarily for anisometropic amblyopia
- Consider for strabismic amblyopia if fusion potential
  - If eyes not aligned, compensate angle with prism
- Ideally wait till VA 20/70 or better AND fairly equal monocular SKILLS in each eye
Anti-suppression therapy

- Monocular fixation in a binocular field (MFBF)
  - Filters allow only amblyopic eye to see details
- Examples:
  - TV/computer trainer – central plastic color matches amblyopic eye’s anaglyph filter, reduce size of plastic over time
  - Anaglyphic coloring/drawing – typically with red pen, red filter over preferred eye, and no or green filter over amblyopic eye
Anti-suppression therapy

- MFBF Matching Game (Richmond Products)
  - “Biocular” since each eye sees some monocular details
  - Newer version of Franzblau red-red rock
Anti-suppression therapy

- Biocular techniques
  - Cheiroscopic tracing
  - Litetrac mazes
  - Anaglyphic letter chart
  - Computerized techniques
Anti-suppression therapy

- Binocular techniques
  - Pola-mirror – walk aways, add lenses/prisms
  - Anti-suppression strips (anaglyphic or polaroid) over print
  - Gross vergence/physiological diplopia, e.g. Brock string
- Computerized techniques
  - www.sinuousgame.com/
  - Vision Builder software:
    - http://www.oepf.org/product/visionbuilder
    - home-version-0
Anti-suppression therapy research

- Computerized anti-suppression program
- Reduced signal to preferred eye
- Stronger signal to strabismic eye
- Patient must combine information to perform the task
- Patients showed improved VA and stereo
- PEDIG research with Tetris on iPad:
  - Less than one line difference between Tetris and patching
  - Overall, patching a bit better in outcome and compliance
Anti-suppression therapy research

- Custom dichoptic (anti-suppression) action video game with perceptual learning task
  - 23 adult subjects randomized to game play,
    15 to supervised movie viewing while patched
  - Each group had 40 hours of treatment
  - VA in aniso amblyopia improved about 30% in both treatment groups
  - VA in strab amblyopia improved only with video games (~26% improvement)
  - Stereo, CSF, and reading speed improved more in video game group
    (Vedamurthy et al., Vis Res 2015)
Anti-suppression therapy – flicker glasses

- Eyetronix Flicker Glass™ liquid crystal glasses
  - Provide alternate occlusion to break suppression
  - 23 children age 5-17 with aniso amblyopia
  - Eyetronix glasses over habitual Rx, 1-2 hr./day for 12 weeks
  - 26% improved at least 2 lines
  - 89% improved in global stereopsis
    (Vera-Diaz et al., Vision Dev & Rehab 2016)

Motor fusion therapy

- For patients with phorias or intermittent strabismus
  - Smooth (sliding) vergence
    - Vectograms/Tranaglyphs
    - Computerized vergence programs, e.g. VTS4, Vivid Vision (virtual reality)
Motor fusion therapy

- Jump (phasic) vergence
  - Aperture Rule Trainer
  - Eccentric circle cards
  - Lifesaver card
Integration therapy

- Multi-tasking, like real-world conditions:
  - Combine vergence with accommodation (BOP/BIM)
  - Addition of auditory processing or other distractors
  - Fusion of targets integrated with movement
    - Pursuits/saccades
    - Body movement
Follow-up care

- See patient every 1-4 weeks during active VT, depending on VT complexity
- Continue monitoring skills in addition to visual acuity: oculomotor, accommodation, binocularity
- Periodically re-check refraction as sensitivity improves
- Work for 6-10 weeks beyond last acuity/skills improvement before stopping
- Follow patient every 2-3 months for first 6 months after stopping treatment
- Then follow at 6-12 month intervals depending on stability
Case Report 2

- 14 y.o. with combined mechanism amblyopia
- Hx of Rx wear and unsuccessful patching
  - 6° CRET, 4° CRhypoT
  - Rx: OD +8.00 -0.50 x 180, OS +7.00 sph.
  - Visuoscropy: 2° nasal, 1° inferior EF OD
  - Very poor pursuits & saccades
  - AC
- At start of VT, VA was 20/70 OD, 20/20 OS (crowding bars)
  - Active VT for oculomotor, eye-hand, accommodation
    - Prism jumps, fast pointing, lens rock, computer games
  - 1-2 hr./day patching during VT program
Case Report 2, continued

- Progress during 2 months of active VT:
  - Clearing -2.50 D at first, to -7.50 OD at end
  - Achieved 9 cpm with +/-2.50 flippers (20/50 near print)
  - Greatly improved saccadic accuracy and speed on SVI
  - Pursuits 4+, saccades 3+ OD
  - VA 20/50 OD (crowding bars)
  - Visuoscopy: $0^\Delta$ nasal, still $1^\Delta$ inferior EF OD
Questions?
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