Beyond the Patch: Management of Amblyopia with Optometric Vision Therapy

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Active vision therapy procedures for the treatment of amblyopia (with and without eccentric fixation) will be presented. The course will include specific treatment for eccentric fixation, oculomotor skills, eye-hand coordination, form discrimination, accommodation, and suppression.

I. Diagnostic testing review
   A. Case history
   B. Best corrected visual acuity – use of crowding bars
   C. Cycloplegic refraction – emphasis on retinoscopy
   D. Monocular fixation
      1. Visuoscopy – rule out eccentric fixation, microstrabismus
      2. MITT/Haidinger’s brushes – rule out eccentric fixation
   E. Binocular status
      1. Cover test – rule out strabismus
      2. Stereopsis – random dot versus lateral disparity
      3. Worth 4-dot – evaluate suppression
      4. 4Δ BO test – interpret with caution
   F. Ocular health

II. Types of amblyopia – influence specific treatment employed
   A. Isoametropic – active vision therapy less often needed
   B. Anisometropic
      1. Hyperopic
      2. Myopic
   C. Strabismic
      1. Central fixation
      2. Eccentric fixation – unsteady versus steady
   D. Form deprivation

III. Evidence-based treatment
   A. Refractive correction
   B. Occlusion
   C. Follow-up

IV. Active vision therapy
   A. Rationale
      1. Supplemental to patching – not all patients improve with refractive correction & patching alone
2. Address patients who have regressed after patching stopped
3. Improve specific skill deficiencies
   a. Inaccurate monocular fixation
   b. Poor pursuits & saccades
   c. Contour interaction
   d. Spatial uncertainty/reduced eye-hand coordination
   e. Reduced contrast sensitivity
   f. Reduced speed of visual information processing
   g. Reduced accommodative skills: amplitude, accuracy, speed, stamina
   h. Suppression/reduced binocularity

B. Categories of vision therapy
1. Fixation/oculomotor
   a. Fixation accuracy & steadiness
      (1) Fast-pointing
      (2) MITT
      (3) Afterimage transfer – only if normal correspondence
   b. Saccades
      (1) Monocular prism jumps – gross to fine
      (2) Sanet Vision Integrator and other computer programs
      (3) Letter charts and tracking exercises
      (4) Progress from isolated to crowded targets
   c. Pursuits – progress from small to large excursions
      (1) Rotators
      (2) Computer programs

2. Figure ground
   a. Hidden pictures
   b. Puzzles, including those with letters/numbers

3. Spatial localization/eye-hand coordination
   a. Pattern duplication – pegboards
   b. Picking up small objects
   c. Coloring, mazes
   d. Video games
   e. Amblyopia iNet software

4. Pattern/shape recognition
   a. Resolution of fine detail – reading, design discrimination
   b. Visual memory – tachistoscopic presentation of stimuli
   c. Perceptual learning paradigms
5. Accommodation
   a. Amplitude
   b. Accuracy
   c. Facility
   d. Stamina and fine control
      (1) Clear/blur/clear with minus lens
      (2) Clear/blur/clear with transparent letter chart

6. Anti-suppression – for patients with fusion ability
   a. Monocular fixation in a binocular field (MFBF)
      (1) Anaglyphic coloring
      (2) TV/computer trainer — central color matching amblyopic eye’s filter
      (3) MFBF Matching Game
   b. Biocular & binocular anti-suppression
      (1) Cheiroscopic tracing
      (2) Litetraic mazes
      (3) Anaglyphic letter chart
      (4) Computerized techniques
      (5) Pola-mirror
      (6) Anti-suppression strips
      (7) Gross vergence/physiological diplopia, e.g. Brock string
      (8) Binocular anti-suppression research (anaglyphic Tetris game)

7. Motor fusion – for patients with phorias or intermittent strabismus
   a. Smooth (sliding) vergence
      (1) Vectograms/Tranaglyphs
      (2) Computerized vergence programs
   b. Jump (phasic) vergence
      (1) Aperture Rule Trainer
      (2) Eccentric circle cards
      (3) Lifesaver card
   c. Integration of vergence with accommodation and versions

8. Strabismus therapy if possible
   a. For patients with constant strabismus
   b. Taper patching program, especially if good binocularity is not achieved

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

VI. Case examples
Anomalous Correspondence - Everything You Wanted to Know But Were Afraid to Ask

Richard London, OD, MA, FAAO
Pacific University College of Optometry

“The World Would Be a Happier Place if No One Had Thought About Anomalous Retinal Correspondence”
Arthur Jampolsky 1973

Why Develop AC?

- Prevents Diplopia and Confusion
- Preserves Some Degree of Motor Fusion
- Attempt to Restore Some Binocularity

How Can AC Develop?

- Could be the sensory system adapting to a motor anomaly
- Could develop from the same neurologic process that causes the motor anomaly
- Could be a motor misalignment resulting from an inherent sensory defect

Understanding Basics

Sensory And Motor Fusion

- Sensory Fusion
  - Images seen by each eye integrated into a single percept
- Motor Fusion
  - Movement of the two eyes responding to disparate retinal stimuli
  - Maintains corresponding retinal areas

Normal Projection
Visual Confusion

Diplopia (ET and NC)

Suppression: Friend Or Foe?

Suppression
- Active
- Unconscious
- Involuntary
- Cortical Inhibition of One Eye Present Under Binocular Conditions

Characteristics
- LATERALITY
  - Unilateral or alternating
- FREQUENCY
  - Constant or intermittent
- SIZE
  - Foveal $\leq 1^\circ$, Central 1 -5°, Peripheral $\geq 5^\circ$
    - Refers to target size
    - Size of the suppression zone increases with size of deviation

Characteristics
- Intensity
  - Shallow to Deep
- How Easily Broken Down
- Depth Tends to Go Along With Frequency Rather Than
Size of Deviation

18  ✅ Suspension

- Ignoring Image
- Can Be Brought Into Awareness
- Good Result In Older Patients With Acquired Strabismus

19  ✅ Motor Fusion

- (T) ± Normal Time Course
- T With AC Often Anomalous Motor Response
  - Slow
  - Attempt to maintain anomalous sensory status

20  ✅ Out-Of-Instrument Evaluation

- Most Appropriate for Primary Care Office
- Measure With and Without Neutralizing Prism
- Second Degree Targets (Normal Illumination / Dark Room)
  - Red lens
  - Worth dot
- Third Degree Targets
  - Random dot best

21  ✅ Worth Dot Test

22  ✅ TNO Stereo Test

23  ✅ LANG I

24

30  ✅ In-Instrument Evaluation

- Most Control With Constant Strabismics
- Major Amblyoscope (Synoptophore) Offers Most Options
Not Found in Most Primary Care Settings
Wheatstone or Brewster Stereoscope May Be Used

Ruling Out AC

What’s Your Angle?

Angle H (“D” in Caloroso & Rouse)
The angle by which the visual axis of the deviating eye fails to intersect the target of regard
Manifest in strabismus
Latent in heterophoria
Where the eye is pointing
Must account for EF

What’s Your Angle?

Point Z (Zero Measure Point)
Point on the deviating eye that receives the image fixated foveally in the nondeviating eye

Angle S
The angle between Point Z and the point in the same eye that corresponds to the fovea of the fixating eye
Where the eye thinks it is pointing

What’s Your Angle?

Angle A (Angle of Anomaly)
The angle between the fovea of one eye and a point in that eye that corresponds to the fovea of the other eye

Determining Correspondence

Normal Correspondence
9 < H = < S
9 < A = 0

37 Harmonious AC (HAC)
  ➢ < S = 0
  ➢ <H ≠ 0
  ➢ < A = < H
  ➢ Point Z Has the Same Visual Direction As the Fovea of the
    Non-deviating Eye <H ≠ 0
  ➢ This is a complete adaptation

38 Subjective Angle = 0

39 Unharmonious AC (UAC)
  ➢ < S is less than < H, but greater than 0
  ➢ < A ≠ < H

40 Angles Of Correspondence

41 Primary Care Tests Of Correspondence
  ➢ Bagolini Lenses
    ➢ Most Natural Testing (Most AC?)
    ➢ Shows Subjective Angle
    ➢ Remember UCT (Douse)!!!
  ➢ Hering-Bielschowski After Image
    ➢ Direct Measure of ϑ A
    ➢ Least Natural
  ➢ Red Lens
    ➢ Measure Subjective Angle
    ➢ Compare to Objective

42 Bagolini Responses - Remember UCT

43 Douse Test On Amblyoscope
44 Hering -Bielschowskia I

45 Red Lens Test

➤ Measure of Subjective Angle
➤ Vertically Separate Images With Prism
➤ Align With Horizontal Prism
➤ Compare to Objective Angle
➤ If Not Equal, AC

46 STRABISMUS PROGNOSIS

47 FLOM’S BARN

48 STRABISMUS
GOOD NOT SO GOOD
➤ Later Onset
➤ Comitant
➤ Intermittent
➤ Nonamblyopic
➤ Accomodative ET
➤ Angle < 20∆ (NC)
➤ Central Fixation
➤ NC
➤ Good Fusion

49 Theories and Implications

50 Theories Of AC Development

➤ Sensory Theory
➤ Motor Theory
➤ Innate Theory

51 Sensory Theory
Sensory (or Adaptive) Theory Basic Concepts

- Binocular vision is not inborn
- A series of conditioned reflexes develop in the first three years of life to produce binocular input to the cortical cells leading to the development of binocularly driven cells in the cortex.

Basic Concepts

- In young strabismic patients sensory adaptations overcome diplopia and confusion.
- These sensory adaptations are:
  - suppression
  - abnormal (anomalous) correspondence (AC)

Sensory Theory

- Probably Most Accepted
- Burian (1945)
- AC is a Sensory Adaptation to Strabismus
- Cortically Shifts Subjective Visual Direction to Restore Some Binocularity
- "Depth of AC"

Depth of AC Tests

- Bagolini lenses (most natural)
- Amblyoscope
- Red Lens or Worth Dot
- Hering-Bielschowsky in normal light
- Hering-Bielschowsky in dark (most unnatural)

Problems With Sensory Theory

- Difficult to Explain UAC
- Artifact of testing?
- Point-to-large-area correspondence
 Modification of <H following start of adaptation
Difficult to Explain Co-Variation / Dual Correspondence

57 Therapy Based On Sensory Theory

- Forced Elimination
- Vary Fixation Point
  - Variable prism
  - Lenses
- Full-time Patching

58 Forced Elimination

- Amblyoscope Technique
- Stimulation at Objective Angle
  - Set up opposite to normal measurement
  - Fixate with deviating eye, detail
- Full-time Patching Between Visits

59 Vary the Angle

- Prism Overcorrection
  - 15 pd more than angle H
- Variable Prism
  - Use Fresnel, change direction or amount
  - Use of Lenses

60 Full-Time Patching

- Usually With Infants Prior to Surgery
- Alternate Days Until Surgery

61 MOTOR THEORY

62

Morgan (1961) “anomalous correspondence might depend not on sensory adaptations to a strabismus but rather on
whether the basic underlying innervational pattern to the extra-ocular muscles was one which registered itself to consciousness as altering ego-centric direction”.

63 Motor Theory

- Strab and AC Have Same Neuro Cause
  - That cause is different than strab with NC
- Eye Movements Are Either “Registered” (Fusional) or “Non-registered” (Accommodative)
  - Registered - results in changes in retinal correspondence
  - UAC combination of registered and unregistered
  - Explains co-variation

64 Therapies Based on Motor Theory

- Divergence Technique
- Implications for use of added lenses

65 Divergence Technique

- For Esos
- Flom Swing
  - Amblyoscope Procedure
  - Co-Variation
  - Like convergence training for intermittent exo

66 Use of Lenses

- Lenses lead to non-registered movements
- Leave slightly undercorrected – allow for some fusional vergence - re-registered

67 Innate Theory

68 Innate Theory
Hering, Worth (19th century), Kerr (1997)
Assumes State of Correspondence Present at Birth
Modified Approach by Kerr
Suggests AC may lead to strab
Disparity detectors faulty

Mechanism
AC involves a neurological disorder in the disparity detection mechanism
On the convergent side for esotropia
On the divergent side for XT

Therapies for Innate?
None effective
Prism or surgery only produce vergence movement that produce anomalous motor fusion
The heterotropia is not eliminated

Summary
Sensory Theory - motor first; sensory adapts
Innate Theory - sensory first; motor follows
Motor Theory - motor and sensory have common origin; simultaneous

How Can This Relate to Processes in “Normal Patients?”

Types of Ocular Deviations
Strabismus – a manifest deviation
Phorias – a latent deviation
But, there is something else now known as Fixation disparity

Comparisons
Both AC and FD can be viewed from motor or sensory perspectives
The Innate theory suggest problems with disparity detectors – related to type II & III?
Can FD be on the same continuum as AC?
Intermittent Exotropia: Our Top Ten Tips

BVPPO Diplomate Preparatory Course 2015

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Course Description: Classification criteria, photophobia symptoms, examination tips, use of the PEDIG IXT control scale, primary versus secondary vertical deviations, musings on overminus treatment, considerations for refractive error correction, results from the recent PEDIG randomized trial on part-time patching (IXT-2), vision therapy issues, and pathological diplopia awareness training will be discussed. 2 hours

1. Photophobia
   - Symptom unique to IXT?
   - Mechanism?

2. Cover testing
   - Controlling fixation and accommodation
   - Variability
   - Remote test distance
     - 3m vs. 6m data
     - 3m vs. mirrored room

3. How to access control?
   - Patient and parental report
   - Cover testing
   - PEDIG IXT control scale
     - How to perform
     - Association with magnitude of deviation?
     - Association with stereoacuity?
     - Number of measures required: single control vs. triple control

**Intermittent Exotropia Control Scale**

5 = Constant Exotropia
4 = Exotropia > 50% of the 30-second period before dissociation
3 = Exotropia < 50% of the 30-second period before dissociation
2 = No exotropia unless dissociated, recovers in >5 seconds
1 = No exotropia unless dissociated, recovers in 1-5 seconds
0 = No exotropia unless dissociated, recovers in <1 second (phoria)
4. What happens when XT is manifest? How to assess?
   - Diplopia
   - Suppression
   - Anomalous correspondence
     - Covariation
     - Hering Bielschowsky Afterimage test
     - Worth dot test

5. Associated vertical deviation
   - Primary vs. secondary
   - How to assess?
     - Cover testing?
     - Fixation disparity instrument
   - Implications when prescribing prism
     - Associated phoria

6. Refractive correction considerations
   - Goal to provide equally clear retinal images
   - For IXT, Rx least plus to BCVA
   - Moderate and high myopia
   - Management of moderate to high hyperopia
   - Treatment in its own?

7. Musings on overminus-lens therapy
   - Passive treatment: Rx more minus than refraction
   - Patient profile: young patients with good accommodative amplitudes and normal to high AC/A (Basic & DE Tx) unable to do other treatments]
   - Theories
     - Magnitude reduced by stimulating A/C
     - A/C triggers fusional vergence
     - May allow clear distance vision, facilitating fusion
   - Prescribing guidelines
     - How much minus?
     - Combine with base-in prism?
     - IXT frequency more important than magnitude
   - Length of treatment?
   - Parent education
   - Myopia progression?
     - Data from studies
8. Part-time patching
   • PEDIG IXT-2 study on part-time patching
     – Study Objectives
     – Major eligibility & exclusion criteria
     – Methods
       1. Baseline Testing
          a. Cover testing
          b. Stereopsis
          c. Control scale
       2. Follow-up Visit Schedule
       3. Primary Outcome Measure
          a. Deterioration
             i. Eye alignment decompensation
             ii. Stereopsis loss
     – Results
       1. Primary Outcome
       2. Secondary Outcomes
     – Discussion/conclusions
       • Age <3 years
       • Age 3 to <11 years

9. Musings on vision therapy
   • Sequencing
     – Near to far
     – Level of fusion
     – If and when to incorporate diplopia awareness training
   • Pathological diplopia awareness training
     Dark room and filters
     Vertical prism
   • Divergence therapy
   • Type of fusion targets (1° vs. 2° vs. 3°) during vergence therapy
   • Modification for patients with covariation
     – Use of afterimages

10. Classification
    • CI
    • Basic
    • DE
      – Pseudo
      – True
“Open Lab” Workshop: Review of EF and AC Procedures and Hands-on Review of Vision Therapy Procedures

This self-paced “open-lab” style workshop will allow candidates to pick and choose testing procedures and therapy techniques they would like to review. Equipment and practice scripts will be available for the assessment of monocular fixation and correspondence along with a variety of standard vision therapy equipment. Individuals will be available to answer questions.

Participant Learning Outcomes

1. The participant will be able to describe and appropriately apply tests used to evaluate monocular fixation including visuoscopy and Haidinger’s brushes.

2. The participant will be able to describe and appropriately apply tests used to evaluate correspondence, including: Bagolini Striated Lens test for correspondence, Hering Bielschowky After-image test for correspondence, Red Lens Test for correspondence, Haidinger’s Brush and After-Image Transfer test for correspondence, Bifoveal Test of Cüppers, and Major Amblyoscope (Synoptophore) for correspondence.

3. The participant will be able to describe and utilize vision therapy techniques used to improve motor fusion including: Vectograms and Tranaglyphs, Wheatstone Mirror Stereoscope, Aperture Rule Trainer, Chiasoptic and Orthopic Fusion, and Brewster Stereoscope.

4. The participant will be able to describe and utilize vision therapy techniques used to treat suppression.

5. The participant will be able to apply methods of modifying VT techniques to both increase and decrease the demand or level of difficulty.

TESTS USED TO EVALUATE MONOCULAR FIXATION

Visuoscopy
1. Target
2. Patient instructions
3. Interpretation of results

MITT/Haidinger’s brushes
1. Target
2. Patient instructions
3. Interpretation of results
4. Modifications for use for treatment of EF
Brock Giver Afterimage Transfer Test
1. Target
2. Patient instructions
3. Interpretation of results
4. Modifications for use for treatment of EF

TESTS USED TO EVALUATE CORRESPONDENCE
Bagolini Striated Lens test for correspondence
1. Target
2. Patient instructions
3. Interpretation of results

Hering Bielschowky After-image test for correspondence
1. Target
2. Patient instructions
3. Interpretation of results

Red Lens Test for correspondence
1. Target
2. Patient instructions
3. Interpretation of results

Haidinger’s Brush and After-Image Transfer test for correspondence
1. Target
2. Patient instructions
3. Interpretation of results

Bifoveal Test of Cüppers
1. Target
2. Patient instructions
3. Interpretation of results

Major Amblyoscope (Synoptophore) for correspondence
1. Target
2. Patient instructions
3. Interpretation of results

VISION THERAPY TECHNIQUES USED TO IMPROVE MOTOR FUSION
Vectograms® and Tranaglyphs
1. Targets
2. Patient instructions
3. Changing demand
4. Therapist tips
Wheatstone Mirror Stereoscope
1. Target
2. Patient instructions
3. Changing demand
4. Therapist tips

Aperture Rule Trainer
1. Target
2. Patient instructions
3. Changing demand
4. Therapist tips

Chiastopic and Orthopic Fusion
1. Target
2. Patient instructions
3. Changing demand
4. Therapist tips

Brewster Stereoscope
1. Target
2. Patient instructions
3. Changing demand
4. Therapist tips

ANTI-SUPPRESSION TECHNIQUES
Monocular fixation in a binocular field (MFBF) techniques
1. Target
2. Patient instructions
3. Therapist tips

Anaglyphic therapy
1. Target
2. Patient instructions
3. Therapist tips

Biocular VT – cheiroscopic tracing
1. Target
2. Patient instructions
3. Therapist tips

OTHERS
Accommodation: clear/blur/clear