Infantile Esotropia: Its Origin, Diagnosis and Potential Therapies

W.C. Maples, O.D., M.S.,
FAAO, FACBO, FCOVD
Professor Emeritus of Optometry
Northeastern State University: Oklahoma College of Optometry

OPTOMETRY HAS NEVER EMBRACED PREVENTION!

- THE TRIAD OF VISUAL DEVELOPMENT
- Amblyopia
  - Constant Unilateral Esotropia
  - Anisometropia-Generally High +
- Constant Alternating Strabismus?
  - No Amblyopia
- Amblyopia a problem in Binocularity
  - Must Solve the Binocularity to Solve Amblyopia

1st Case: Subjective

- 19 mo White Female
- Esotropia from before 6 months
- Full Term Pregnancy: No problems with pregnancy or birth-First Child
- Crawled at 6 months
- Walked at 10 months
- Threw tantrums and wanted things her way when tired

1st Case: Subjective Continued

- O-MD exam at 6 months (Concern)
- Healthy Eyes
- Congenital Esotropia
- Cycloplegic Rx dispensed (+2.25D sph OU) and told to return in 6 months if not straight surgery would be suggested

1st Case: Objective

- Hyperactive Child
- Present RX +2.25 – (Kept Rx)
- Retinoscope at far +1.50
- EOM's full--OS less accurate
- Head Movement
- Uncoordinated Visual Motor Patterns (Body)
- Eyes Healthy

1st Case: Assessment

Infantile Esotropia OS with Hyperopia

1st Case: Education

- No Guarantees
- Goal:
  - **Straight Eyes**
  - **Diminish the Rx if Possible**

1st Case: Plan

- Lenses (+2.25 SV)
- Home Vision Therapy
  - Office Visit **2/week**
- Later 1/week as a progress examination

1st Case: Initial Tx

- Periodic Patching (short periods of time- more OD than OS)
- Movement Patterns of Head, Neck and Body
  - Prone Neck Rotations
  - Dry Land Swimming
  - Crawling
    - Bright Objects---Cross Patterning--VT depends on motivation (Time at Task)
  - Sleep Patterns

1st Case: Early Progress Exams

- 2 Weeks: Change Rx to +1.50 c +0.75 add
  - Mother reports eyes are straighter
- 6 Weeks: Change +1.50D with Bi-Nasals
  - Mother reports steady improvement of eyes-eyes are straighter longer
- 9 Weeks: Change Rx to +0.75 c +0.75 Add
- 14 Week: Change Rx to +0.75 and released without bi-nasal occlusion

1st Case: Later Progress Exams

- 1 month post release:
  - Goes without lenses
  - Eye does not turn normally
- Turns if tired or excited
- 3 months post release:
  - Eyes seldom turn
  - Seldom wears Rx

Long Term Follow Up

- All State Basketball
- All State Tennis
- Full scholarship Southern Miss: Tennis
- Entrepreneur
  - Real Estate
  - Timber
- 44 years of Age
- Mother of 2
- Parents Never Told the Child Her Eye Crossed

Why? How?

- Infantile Esotropia has intrigued me since this time.
- Why did the eyes straighten?
- What happened to the hyperopia?
- Is there a logical neurological mechanism?
- Is the Developmental Triad A Preventable Condition?

Susan Barry Ph.D.
Fixing My Gaze

Guest Editorial: Thwarted at every turn. Optometry;2009

Susan Barry

- Most strabismic patients seeking improved vision are thwarted at every turn
- Worth: congenital weakness of the fusion facility
- Chavasse: Reflexes of early childhood
- Medical community over-extrapolated…little consideration for differences between the experimental conditions and human disorder. What had been opinion became dogma.

Sue Barry
Fixing My Gaze

- Barry SR. Fixing my gaze: A scientist's journey into seeing in three dimensions. Basic Books New York; 2009.
  - "It had been widely thought that an adult, cross-eyed since infancy, could never acquire stereovision, but to everyone's surprise Barry succeeded….she describes how wonderful it was to have, step-by-step, this new 3D world revealed to her." (David H. Hubel)

Sue Barry
Fixing My Gaze

- Forward: Oliver Sacks
  - David Hubel and Torsten Wiesel: kittens rendered strabismic…would fail to develop in their brains…lack stereo vision.
  - Visit to prove stereo vision
  - "require not only optical…learn how to align…and fuse images, while unlearning the unconscious habit of suppressing vision…occurring for perhaps decades."

Lesson from Adult Strabismus

- Don't Give Up!
- It is never too late to improve the visual process
- It, however is much easier if one catches it early before the seeing habit of strabismus is embedded!

Examination: Child Development A Starting Point

- Apgar
- OB's reports
- Length in Hospital
- Reflexes and Mass Activity
- Stimulation
- Inner Ears
- Child Development for first year/Preschool
- CRITICAL CASE HISTORY!

Evidence for Developmental Hx

Major A, Maples WC, Toomey S, DeRosier W, Gahn D. Retrospective study of factors associated with infantile esotropia. Optometry 2007;78;534-41.

- What factors are associated with infantile esotropia
- Infantile Esotropia Defined
  - Onset prior to 6 months
  - Angle =/> 30^
  - Constant Deviation
  - Alternation Common
  - = Angle Far and Near
  - Ametropia Mild to Moderate (+ no help)
  - IO Overaction-DVD (Double Vertical Deviation)
  - Latent Nystagmus
  - Asymmetric OKN (Nasal to Temporal Undeveloped)
  - Accommodative component may be present (Later)

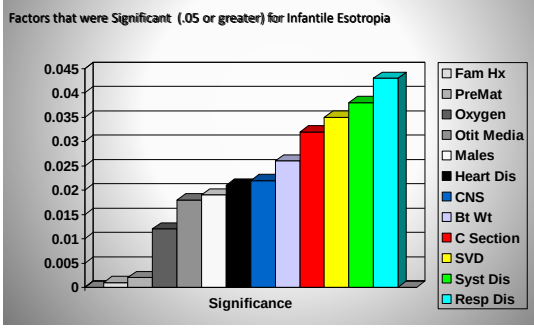
Evidence for Developmental Hx

Major A, Maples WC, Toomey S, DeRosier W, Gahn D. Retrospective study of factors associated with infantile esotropia. Optometry 2007;78:534-41.

- Pulled Hastings Records and Looked for Infantile Esotropia Dx that had not been previously treated
- Compared to matched non esotropes by age and gender
  - Twenty Six Factors Evaluated
  - Twelve were significant at .05 or better

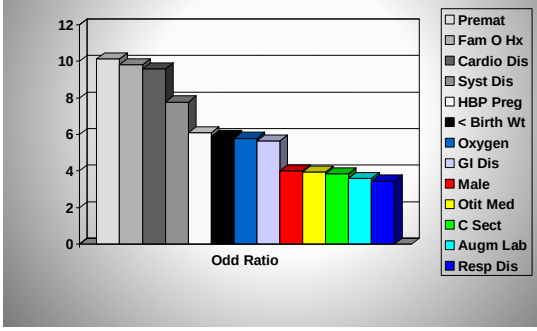
Evidence for Developmental Hx

Major A, Maples WC, Toomey S, DeRosier W, Gahn D. Retrospective study of factors associated with infantile esotropia. Optometry 2007;78:534-41.



Evidence for Developmental Hx

Major A, Maples WC, Toomey S, DeRosier W, Gahn D. Retrospective study of factors associated with infantile esotropia. Optometry 2007;78:534-41.



Evidence for Developmental Hx

Major A, Maples WC, Toomey S, DeRosier W, Gahn D. Retrospective study of factors associated with infantile esotropia. Optometry 2007;78:534-41.

- Other Odds Ratios
  - Vacuum/forceps Delivery 2.95
  - Secondary Ocular Disease 2.14
  - No Smoker in Home 1.80
  - No Over the Counter Meds 1.74
  - Peri-natal Complications 1.73
  - No Breastfeeding 1.52
  - Mother's Age over 20 1.43
  - Prenatal Care Given 1.36
  - No Prescriptive Meds 1.35
  - Tylenol Use 1.33
  - Amoxicillin/Ampicillin Use 1.25

Child Development Activity

- In Utero
  - 1st Trimester- All Organs Formed- Drugs Devastate
  - 2nd Trimester- Growth- Begin a Gentle Exercise Program
  - 3rd Trimester- Maturity- Continue Gentle Exercise and Begin to play music and read aloud
- Birth to 1 year

A Baby At Birth

- Reflexes and Mass Activity
- Law of Developmental Direction
- Phylogenetic (Crawling-Pointing)
- Ontogenetic (Language-Diet-Walk-Squat)
- Law of Developmental Direction
  - Head To Toe
  - Internal To External
  - Midline to Extremities
  - Large Muscles to Small Muscles

Habilitation/Rehabilitation

- Amblyopia
  - Anisometropia:
    - **Measures vary**
    - **Almost always high + in the amblyopic eye**
  - Strabismus (Esotropia)
- ***Commonality of Therapy is Development of Binocularity***

Synergestic Models for Infant ET

- Brock: Eyes Point Straight-Fusion Happens
- Streff: Neurological Development by Reaching out Visually and Motorically (Visual Lures)
- Immaturity to Maturity of Cortex (Pruning & Increased Complex Cortical Development)-Held
- Interaction of drive to esotropia (nasal bias of OKN) and drive to fusion (disparity) Tychsen.
- All are compatible with the Developmental Model

Must Reading

- Helveston E. 19th Annual Costenbader Lecture on Congenital Esotropia. J Ped Opthtalmol Strab 1993 215-32.
- Thorn F, et.al. The development of alignment, convergence and sensory binocularity. Invest Ophthalmol Vis Sci 1994 544-53.

Sequence of Infantile Strabismus

- Children are not Born Binocular
- Appears to Happen Suddenly at about 3 to 4 Months of Age
- Binocularity Appears to be Developmental
- Clinically Noted to be Associated with the Time the Child Loses the Asymmetric TNR
- If not Binocular: Then Infantile Esotropia Likely

The Rationale for Therapy

- Child Development
- Follow the Developing Child
- First 4 months are critical
- Labyrinthine Stimulation-In Utero and Perinatal
- It is as IMPORTANT WHAT YOU DO NOT DO—AS WHAT YOU DO!
  - Encourage Symmetry of Movement and Fixation

Esotropia at Birth

- True Congenital ET: ***VERY RARE!***
- Typically the neonate will show binocularity at 4 months
- **Infantile Esotropia after 4 months (85%)**
- **Infantile Exotropia after 6 months (15%)**

Congenital Esotropia?

- **Not common in new born (0/500)**
- **High percentage new born have transient exotropia**
- **(N=1,219) neonate exams-not 1 case of congenital esotropia (at birth)**

"Congenital" Esotropia Defined

Helveston J Ped Ophth 1993 215-32.

- 10-90^
- Normal neurology
- + does not eliminate tropia
- Present by 6 mo
- **{Not Congenital but Infantile}**

VonNoorden Criteria After Surgery

- Subnormal Binocular (Optimum)
  - 0/Asymptomatic phoria---20/20 Each Eye--NRC--Fusional Amps--Foveal suppression--Low/no Stereo--Stability of alignment
- Microtropia (Desirable)
  - Undetectable shift on cover-Mild amblyopia-ARC-Fusional amplitudes--EF--Low/no Stereo-Some Stability on Alignment
- Small Angle Tropia (Acceptable)
  - Less than 20 ^--Amblyopia--80% ARC

VonNoorden Says

- Surgery should be completed before 2 years of age on infantile esotropes
- Functionally useful vision is possible after this age however
- Optimal & Desirable Groups: Added together is better after 4 years
- % of unacceptable surgical outcomes less when surgery performed after age 4

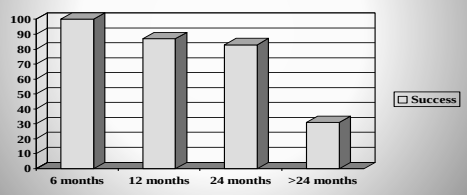
Surgery: Pre-Post 2 Years

VonNoorden

- N=358
- Only those corrected (not the failures)
- "all treated patients…included, fewer patients…obtained such good results"
- Included:
  - Stereo on vectographs or Worth 4 dot fusion
  - Residual tropia of < 10^

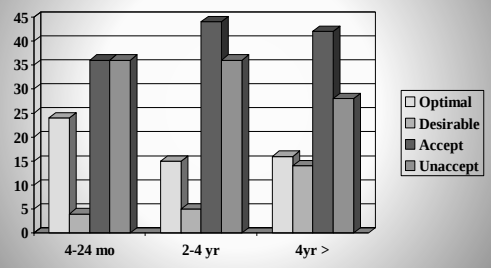
Success based upon age when surgery was performed: Only successful patients included

VonNoorden (See Next Slide for % Successful)

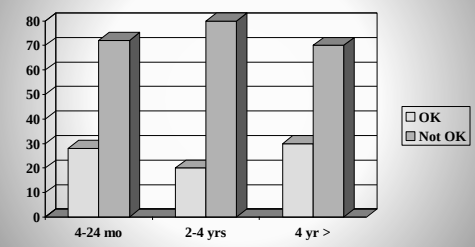


Surgical Outcome by Age (VonNoorden) Percentage

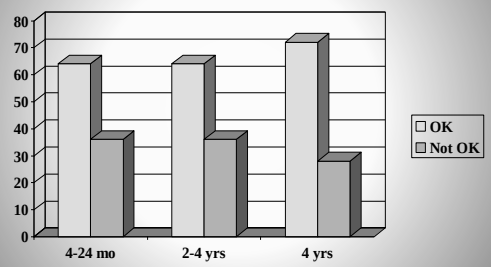
24,4,36,36; 15,5,44,36; 16,14,42,28



VonNoorden: Optimal/Desirable vs Acceptable (<20^) or Unacceptable



VonNoorden: <20^ or better by age



Helveston's Quotable Quotes

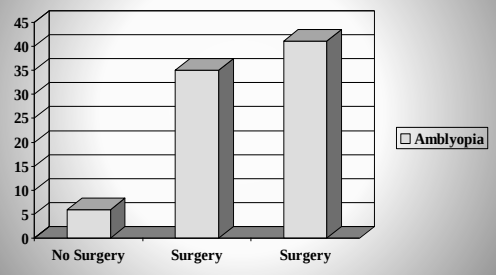
"Reoperation rates up to and including the 1960's was 50%"

"Medial rectus insertion site was found to have no relationship to the angle of deviation in esotropic patients"

Helveston: **"untreated…congenitally esotropic patients…teens or older"**

- **Esotropia remained but only 6% were amblyopic**
- **Of those treated: Amblyopia was 35% and 41% in a series of treated congenital esotropia patients**

Congenital esotropia vs. amblyopia: surgery or none



"deviations characteristic of congenital…esotropia are not present at birth…rather an anomalous developmental process resulting in esotropia occurs in the first few weeks or months of life"

Nixon, Helveston, Miller, et. al. Incidence of strabismus in neonates. Am J Ophthalmology 1985;100:798-801.

Helveston: **"Reports from a variety of diverse sources have in common the following:**

- **No patient with a confirmed congenital esotropia has completely normal binocularity after treatment (surgery)**
- **A wide array of seemingly unrelated motor anomalies develop after treatment, frequently after a latent period and in spite of early and accurate alignment**

Another Case: Infantile ET

- 9 mo when seen in church
- Informal Hx reveals being seen by a pediatric OMD and a GP OD
- OMD Rx cycloplegic and told will surely need surgery
- GP OD: Unsure as to what to do
- How about I call the GP OD and talk?

Infantile ET # 2

- Take high + lenses off (low +) and begin LOTS of motor work particularly with labyrinthine
- Consider Bi-Nasals

- Mother reports in appx. 1 month
- Eyes are straighter-Now Straight (2 mo)
- Sometimes straight-O MD considers it a "spontaneous cure" but will still probably need surgery in the future

The Importance of the Cx

- Infant Toddler (InfantSee Hx) can give much insight into possible problems

- The History Is Important!

- ***HIGH RISK! PRE-DISPOSITION NOT PREDESTINED***

Therapy for Infantile ET

- The best is to prevent-The Infantile Triad-All, In my opinion, Related to the **DEVELOPMENT OF BINOCULARITY**
  - Amblyopia
  - Anisometropia
  - Infantile Strabismus
- Optometry needs to move into ***prevention***

Bilateral Integration

- The Law of Developmental Direction
- Developing Hering's and Sherrington's Laws
- Labyrinthine Stimulation
- Proprioceptive/Kinesthetic Stimulation

Infantile Visual Hygiene

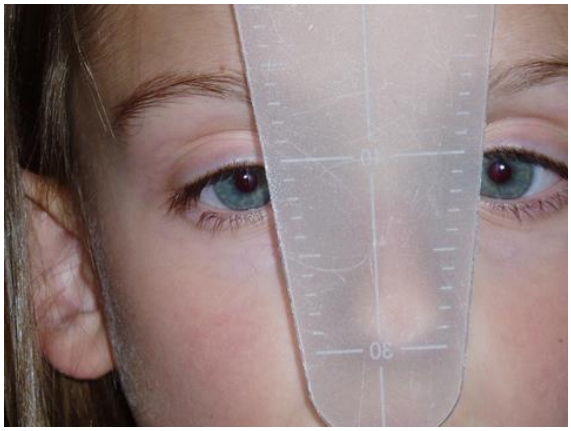
- **Fixate the human face (Black-White)**
- **Encourage fixation of each eye**
- **Mother moves face laterally close to baby's face while mother talks to the baby**
- **Checker type bumpers for cribs**
- **Gentle bilateral massage**
- **Stimulation of both sides of the body alternately and simultaneously**
- **Move crib often and keep in center of room**
- **Allow freedom of movement**

VT For the Infant/Toddler Developing Neurological Firing

- Monocular Pursuits and Saccades (Wide Excursions---Slap the Sockets)
- Binasal Occlusion (Binocular)
- Graded Occlusion (Penalization) Bangerter Foils, Clear Fingernail Polish, Excess Plus
- Peripheral Stimulation
  - Food Handling-toys to non dominant side
- Bilateral Activities/Labyrinthine Stimulation
  - Give Me 5, Balance Board, Creeping, Crawling, Rolling, Trampoline, Basic Body, etc

Slap The Sockets

BiNasal Occlusion



Infantile Vision Therapy

- **Bilateral massage**
- **Left-right neck motion (Mother talking)**
- **Beach ball roll**
- **Pull Ups**
- **Bicycling**

BILATERAL MASSAGE

LEFT RIGHT NECK ROTATIONS

BEACH BALL ROLL

PULL UPS

BICYCLING

Labyrinthine-Proprioceptive-Kinesthetic Stimulation

- **Beach Ball (Advanced: Sitting)**
- **Pull Ups (Advanced: Broom Handle)**
- **Line Roll**
- **Neck Rotations**
- **Rotating Chair**
- **Optokinetic Nystagmus**

Basic Body Techniques

- **Angels in the Snow**
- **Dry Land Swimming**
- **Creeping**
- **Crab Walk**
- **Romper Stompers**

ANGELS IN THE SNOW

DRY LAND SWIMMING

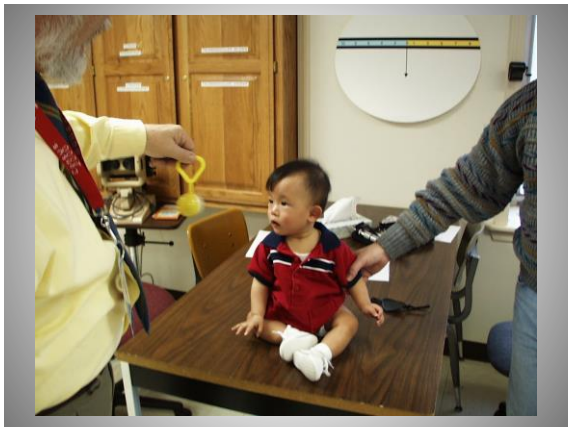
CREEPING

CRAB WALK

ROMPER STOMPERS

Ocular Motilities

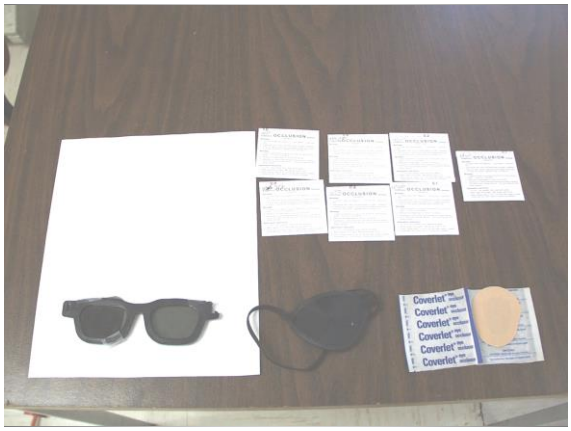
- Parent Moves Baby
  - Horizontal, Down, Up, Rotational
- Bright Object
  - Black and White Early in Life-Later Colors
- Noisy Object
- Bright and Noisy Object
- Broad “H”



Optical Rx

- Low Plus and Symmetrical
- Binasal
- Direct Occlusion (Not Often Used)
  - Patching (Only for Special Cases)
- Graded Occlusion (Encourage Less Active Eye)
  - Bangerter Foils
  - Clear Finger Nail Polish
  - Translucent Tape
  - EXTRA PLUS ON DOMINANT EYE

Graded Occlusion



Conclusion

Infant eye and visual assessment is within the scope of the primary care optometrist. Management of high risk infants, pediatric ocular disease and complex visual conditions such as strabismus, amblyopia and abnormal refractive conditions often requires a pediatric ***optometric*** management team.