Effective Myopia Control in Clinical Practice...2014

Myopia Control in Children
"Is there anything that can be done to control my child's increasing myopia???

Prevalence of Myopia and High Myopia in 5,060 Chinese University Students in Shanghai
Jing Sun, Jibo Zhou, Peiquan Zhao et.al. Investigative Ophthalmology November 2012
• Mean spherical equivalent refraction -4.12 D.
• 95.5 % were myopic
• 19.5 % were highly myopic (> -6.00 D.)
• Only 3.3 % were emmetropic

Susan Vitale PhD, Robert Sperduto MD, Frederick Ferris MD Archives of Ophthalmology Vol. 127 No. 12 December 2009
Ages 12 -54
1971-1972
25.0%
Myopic
1999-2004
41.6%
Myopic
In 30 years a 17% increase in myopia

For Centuries Scientists and Clinicians have Debated the Question of Whether Myopia is:
• Genetic, (Nature)
  - Ethnicity
  - Family inheritance
• Environment, (Nurture)
  - Molded by visual experience.
Possible Mechanisms
1. Less accommodative demands in outdoor environments.
2. Pupil constriction in brighter light resulting in greater depth of focus.
3. Direct light exposure may releases retinal transmitters
   Dopamine
   Vitamin D
   which may inhibit eye growth.

Myopia or hyperopia can be induced in chicks and reversed by manipulation of the chromaticity of ambient light
WS Foulds, VA Barathi, CD Luu
Singapore Eye Research, IOVS January 2014

- Baby chicks were raised in red light (90% red and 10% yellow/green) and in blue light (85% blue 15% green).
- Exposure time was 12 hour on-off cycle for 28 days.
- Red light induced -2.83 D. ± 0.25 D.
- Blue light induced +4.55 D. ± 0.21 D.
- The refractive changes were axial, confirmed by ultrasound biometry.
- The induced myopia was reversed to hyperopia with blue light exposure (+2.50 D.) and the hyperopia was reversed to myopia with red light exposure (-1.23 D.)

Study Conclusions
The results suggest that the protective effects of outdoor light against myopia in children are due to exposure to the higher light levels in outdoor environments approx 50,000 lux

This raises the possibility that substantial therapeutic benefits could potentially be achieved by manipulating indoor lighting levels that are usually approx. 250 lux

John Ott 1909 – 2000 Landmark work in the 1950’s with time lapsed photography
Father of Full Spectrum Lighting
Myopia Control…
The Search for the Holy Grail

- Bifocal Lenses
  Relaxation of accommodation
- 0.75 D. Undercorrection
  Relaxation of accommodation
- Rigid Contact Lenses
  Improving retinal imagery ???
- Pharmacologic Intervention
  Target specific anatomic structures of the eye
- Optical Intervention
  Peripheral refractive error

What is Meaningful Myopia Control?
A child at age 7 is diagnosed with -1.00 D. which progresses -0.75 D. per year for 8 years.

If Myopia Progression Is Slowed By
Final Myopia Would Be

0% -7.00 D.
50% -3.62 D.
100% -1.00 D

Most eye care practitioner consider a 50% reduction in myopia a “Myopia Control” effect
Walline 2012

Predicted Reduction of High Myopia for Various Degrees of Myopia Control.
Noel A. Brennan OD PhD.
Contact Lens and Anterior Eye BCLA Abstracts 2012

High myopia > -5.00 D. is associated with increased risk of: choroidal neovascularization, glaucoma, cataract and retinal detachment.

Proportion of people who would avoid becoming high myopes with varying degrees of successful myopia control.

Reducing the rate of myopia progression
33% 73%
50% 90%

Myopia Control…
The Search for the Holy Grail

- Bifocal Lenses
  Relaxation of accommodation +18
- 0.75 D. Undercorrection
  Relaxation of accommodation -19
- Rigid Contact Lenses
  Improving retinal imagery ??? -7
- Pharmacologic Intervention
  Target specific anatomic structures of the eye +81
- Optical Intervention OK & MF SCL’s
  Peripheral Optics +50

What Regulates Eye Growth???

1. Emmetropization Studies
2. Form Deprivation Myopia Studies
3. Lens Compensation Studies
4. Reduction Experiments
5. Local Retinal Mechanism Studies
What Regulates Eye Growth???

- In all species, (including humans) the two eyes typically grow in a highly coordinated manner towards the ideal optical state, a process called “Emmetropization”

- The process is regulated by visual feedback.

Fundamental Across All Species

- Rodents
- Primates
- Cats
- Rabbits
- Marsupials
- Birds
- Fish

Survival of the Species

Emmetropization in Infants

Chronic Image Degradation Causes Myopia

Wiesel & Raviola 1977

Monocularly lid-sutured Monkey

Chronic Image Degradation Causes Myopia

Wiesel & Raviola 1977

Conditions that prevent the formation of a clear retinal image cause the eye to grow abnormally long and become myopic.

Form-Deprivation Myopia

The potential for a clear retinal image is essential for normal refractive development.
Form Deprivation Myopia

If an eye that has from-deprivation myopia is corrected with spectacle lenses no recovery takes place.

However, if the eye is allowed unrestricted (uncorrected) vision, the eye will recover through a visual feedback mechanism.

An Intact Fovea Is Not Essential for Normal Axial Eye Growth

An intact periphery is essential for normal axial development.

Hemiretinal Form Deprivation: Evidence for Local Control of Eye Growth and Refractive Development in Infant Monkeys

Peripheral retinal receptors take in visual information and provide the signal for the eye to grow (or to stop growing) in a regionally selective fashion.

Conclusions, Smith et.al. #1

A functioning fovea is not essential for normal axial development.

Conclusions Smith et.al. #2

An intact periphery is essential for normal axial development.

Peripheral retinal receptors take in visual information and provide the signal for the eye to grow (or to stop growing) in a regionally selective fashion.

The vision-dependent mechanisms that regulate eye growth are located IN THE EYE.
Thus, if there is spatial summation of signals from the myopic center and the hyperopic periphery, the peripheral signal will dominate the eye growth.

Myopia Control Studies with Ortho-K

Average +49%

Rule #1, the Optics of OK

The foveal treatment zone in OK is approximately 1.5 to 2.5 mm in diameter.
Post -4.75 LASIK

Post OK -5.00 D.

Rule #2, the Optics of OK

The amount of peripheral plus power at 5.0 mm, is equal to the central minus power corrected.
Rule #2

-2.75 D. Correction

-5.75 D. Correction

-8.75 D. Correction

Pupil Size and Myopia Control

How Hyperopic is the Peripheral Retina at 30 Degrees???

+1.00 D., +2.00 D., +3.00 D. or +4.00 D.
Do Peripheral Refraction and Aberration Profiles Vary with the Type of Myopia?

*The Journal of Optometry 2009*
Ravi Bakaraju, Klaus Ehrmann, Eric Papas, Arthur Ho
Vision Cooperative Research Center, Sydney Australia

Average difference between the foveal refraction and that 30 degrees away was between +1.00 D. and +1.50 D.

Chow 5 Year OK Axial Length Study

- Traditional 5 Curve OK Lens Design N = 165
- Aspheric 6 Curve OK Lens Design N = 129
- Historical Control CLEERE Study 2007

Five Year, CLEERE Study, Axial Length Data
Refractive Errors Age 9 to 14

Traditional 4-5 Curve Design

Chow Study 5 Year Axial Length Data
*Traditional 5 Curve OK Lens Design N = 165*
**Myopia Control 6 Curve Design**

- **Chow Study 5 Year Axial Length Data**
  - **Aspheric 6 Curve OK Lens Design N = 129**
  - **Myopic Children Asian and Non-Asian Children**
  - **Asian Emmetropic Children**
  - **Non-Asian Emmetropic Children**

**Kakita et al 2011**

**Blur Circle and Myopia Control**

The size of the blur circle increases with the distance of the image from the retina.

Therefore, if there is spatial summation of signals from the myopic center and the hyperopic periphery, the peripheral signal will dominate the eye growth.
Graded Competing Regional Myopic and Hyperopic Defocus Produces Summated Emmetropization Set Points in Chicks
Dennis Y. Tse and Chi-ho To IOVS 2011
Center for Myopia Research, School of Optometry, Hong Kong Polytechnic University

Investigated the axial response of the eye when a specific proportion of the retina was exposed to myopic defocus while the remainder was exposed to (competing) hyperopic defocus.

Effects of Traditional Spectacle Lenses on Peripheral Refraction
Tabernero et.al Vision Research (49.) 2009

If lenses were being developed to INCREASE myopia progression...would we ever prescribe those lenses?

Center Distance Multifocal Soft Lens Designs
Cooper Vision Cooper Vision Vistakon

Acuvue Oasys for Presbyopia
Design: CD (Center Distance) DK 103
Base Curve: 8.4 mm
Powers: +6.00 to -9.00 D
Diameter: 14.3 mm
Adds: +0.75 to +2.50 in 0.50 D. steps
The design, incorporates 5 concentric rings with alternating distance and near powers zones.
**Center Distance Multifocal Soft Lens Designs**

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**John Phillips OD PhD New Zealand**

**MiSight**
Manufactured by Cooper Vision
Distributed in Hong Kong, China

**Walline 2011**
Cooper Vision Multifocal “D” Lens
- Children 8-11 (-0.75 to -4.00 D.)
- Historic controls (ACHIEVE Study)
- Proclear Multifocal “D” lens +2.00 D. add
- 2 year results
  - 49% myopia reduction
  - 40% reduction in axial length

**Cooper Vision PROCLEAR MF XR**

- Design: CD (Center Distance) 6 pack
- Base Curve: 8.7 and 8.4 mm
- Powers: +20.00 to -20.00 D
- Diameter: 14.4 mm
- Adds: +1.00 to +4.00 in 0.50 D. steps
Distance Power -3.00 D. +3.00 Add

When?? Ages 7 to 12

Patient History and Myopia Control
- Age of the patient
  - early (genetic) faster progression more severe
  - late onset (acquired) slower progression less severe
- Amount of myopia example 7 y/o
  - +1.00, Plano, -1.00
- Family history
  - mom and dad
- Environment history
  - Outdoor exposure per day
- Contact lenses
  - Patient and parent physically & psychologically
- Practitioner
  - Training and expertise with the various modalities

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Myopia Control

The Future