Myopia Control: Implementing Effective Treatment Options in Clinical Practice

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Etiology of Myopia

Genetics

Environmental

Myopia
The Prevalence of Myopia

- Africa – 10-20%
- United States – 30-40%
- Europe – 30-40%
- Asia – 70-90%
  - Up to 20% are highly myopic
Potential Factors Impacting Myopia Development

• **Refractive Error**
  - Parents’ refractive error
    - 1 myopic parent: 2.17 x risk
    - 2 myopic parents: 5.40 x risk
  - Patient’s current refractive error
    - +0.75 D or less hyperopia with young school aged children

• **Time spent outdoors**
  - Nonmyopes: 11.65 ± 6.97 hours/week
  - Future myopes: 7.98 ± 6.54 hours/week

Jones et al., 2007, Zadnik et al., 1999
Rate of Myopia Progression

Data represents a summary of 20 compiled published journal articles

Donovan et al., 2012
Public Health Considerations

Myopia increases the risk for:

- Retinal holes and tears
- Glaucoma
- Cataracts
- Retinal and vitreal detachments
- Lattice degeneration
- Lacquer cracks
- Myopic macular degeneration

Saw, et al., 2005
Clinically Significant

- An 8-year-old patient presents with a refractive error of -1.00 DS OU

<table>
<thead>
<tr>
<th>Percentage of myopic reduction</th>
<th>Patient’s final refractive error</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>-5.00 D</td>
</tr>
<tr>
<td>25%</td>
<td>-4.00 D</td>
</tr>
<tr>
<td>50%</td>
<td>-3.00 D</td>
</tr>
<tr>
<td>75%</td>
<td>-2.00 D</td>
</tr>
<tr>
<td>100%</td>
<td>-1.00 D</td>
</tr>
</tbody>
</table>

*Estimate myopia progression of -0.50 D per year from ages 8-16
Myopia Control Treatment Options

- **Topical Agents**
  - Atropine
  - Pirenzepine

- **Spectacles**
  - Bifocals
  - PAL’s
  - Undercorrection

- **Contact Lenses**
  - Alignment fit GP’s
  - Corneal reshaping lenses
  - Soft multifocal lenses
Myopia Control Treatment Options

- **Least effective**
  - Undercorrection (-16 to -22%)
  - Gas permeable contact lenses (-5 to -8%)

- **Moderately effective**
  - Soft bifocal contact lenses (34 to 79%)
  - Corneal reshaping contact lenses (36 to 58%)

- **Most effective**
  - Atropine (76 to 96%)

% = reflects the percentage of reduction of myopia progression when compared to a control group
Peripheral Optical Profile

Myope corrected with spectacles or single vision soft contact lenses

Peripheral hyperopic defocus

Image obtained from Dr. Jeffrey J. Walline
Peripheral Myopic Defocus

Myope corrected with center distance soft bifocal contact lenses or corneal reshaping lenses
# Center Distance Soft Bifocal Contact Lenses

<table>
<thead>
<tr>
<th>Brand</th>
<th>Proclear Multifocal “D” and XR “D”</th>
<th>Biofinity Multifocal “D”</th>
<th>Acuvue Oasys for Presbyopia</th>
<th>MiSight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Omafilcon A</td>
<td>Comfilcon A</td>
<td>Senofilcon A</td>
<td>Omafilcon A</td>
</tr>
<tr>
<td>Power ranges</td>
<td>+20.00 to -20.00 D</td>
<td>+6.00 to -8.00 D</td>
<td>+6.00 to -9.00 D</td>
<td>-0.25 to -6.00 D</td>
</tr>
<tr>
<td>Add powers</td>
<td>+1.00 to +4.00 D in 0.50 D steps</td>
<td>+1.00 to +2.50 D in 0.50 D steps</td>
<td>Low, Mid, and High</td>
<td></td>
</tr>
<tr>
<td>Replacement</td>
<td>Monthly</td>
<td>Monthly</td>
<td>Bi-weekly</td>
<td>Daily disposable</td>
</tr>
</tbody>
</table>

Not currently available in the US
Soft Multifocal Contact Lens Studies

Reduction of myopia progression (%)

- Sankaridurg (2011)
- Walline (2013)
- Anstice (2010)
- Holden (2010)
- Aller (2006)
Orthokeratology Safety

<table>
<thead>
<tr>
<th></th>
<th>Children</th>
<th>Adults</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>677</td>
<td>640</td>
<td>1317</td>
</tr>
<tr>
<td>Cases</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Years at risk</td>
<td>1435</td>
<td>1164</td>
<td>2599</td>
</tr>
<tr>
<td>Rescaled incidence rate (95% CI)</td>
<td>13.9 (1.7 to 50.4)</td>
<td>0 (0 to 31.7)</td>
<td>7.7 (0.9 to 27.8)</td>
</tr>
</tbody>
</table>

*Rescaled rate is per 10,000 patient-years

Conclusion: Overnight corneal reshaping contact lenses and other overnight contact lens modalities show similar risks of microbial keratitis

Bullimore, Sinnott, & Jones-Jordan, 2013
Retardation of Myopia in Orthokeratology (ROMIO) Study

% of subjects who progressed >1.00 D

<table>
<thead>
<tr>
<th>Group</th>
<th>Ages 7-8</th>
<th>Ages 9-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ortho-k</td>
<td>20%</td>
<td>9%</td>
</tr>
<tr>
<td>SV spectacles</td>
<td>65%</td>
<td>13%</td>
</tr>
</tbody>
</table>

Cho & Cheung, 2013
Atropine

- Nonselective muscarinic receptor antagonist with high affinity for all five muscarinic receptors
  - All five muscarinic receptors are within the eye

- Concentrations tested:
  - 0.01-1.0%

- Delivery:
  - Solution and ointment

- Dosage
  - 1 GT QHS OU
Atropine Side Effects

- **Systemic**
  - Nervousness
  - Vomiting
  - Headache
  - Fever
  - Dryness of the mouth
  - Tachycardia
  - Constipation

- **Ocular**
  - Mydriasis
  - Cycloplegia
  - Photophobia
  - Burning
  - Allergic reaction
Atropine Studies

- Atropine for myopia control was first conducted in the late 19th century
- ATOM 1 and ATOM 2 (Atropine in the Treatment of Myopia)
  - Use of low concentration atropine
- Fang et al.
  - Prevention of myopia onset
- MIT (Myopia Intervention Trial)
  - Atropine and multifocal spectacles
- Yen et al.
  - Comparison of 1% atropine, 1% cyclopentolate, and saline
Atropine’s Mechanism of Action on Myopia Control

- Non-accommodative mechanism
- Retinal
- Scleral
- Choroidal
- Non-muscarinic
- Progression after cessation
Atropine: Side Effects

<table>
<thead>
<tr>
<th>Atropine (A) Dose, Mean (SD)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A 0.01%</td>
<td>A 0.1%</td>
<td>A 0.5%</td>
<td>P Value</td>
</tr>
<tr>
<td>Accommodation (D)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- at 1 yr</td>
<td>11.7 (4.3)</td>
<td>6.0 (3.4)</td>
<td>3.6 (3.2)</td>
<td>&lt;0.001*↑↑</td>
</tr>
<tr>
<td>- at 2 yrs</td>
<td>11.8 (3.2)</td>
<td>6.8 (3.4)</td>
<td>4.0 (2.6)</td>
<td>&lt;0.001*↑↑</td>
</tr>
<tr>
<td>- mean change over 1 yr</td>
<td>-4.4 (4.9)</td>
<td>-10.9 (4.0)</td>
<td>-12.4 (3.3)</td>
<td>&lt;0.001*↑↑</td>
</tr>
<tr>
<td>- mean change over 2 yrs</td>
<td>-4.6 (4.2)</td>
<td>-10.1 (4.3)</td>
<td>-11.8 (4.4)</td>
<td>&lt;0.001*↑↑</td>
</tr>
<tr>
<td>Mesopic pupil size (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- at 1 yr</td>
<td>5.1 (0.9)</td>
<td>6.7 (1.0)</td>
<td>7.5 (1.1)</td>
<td>&lt;0.001*↑↑</td>
</tr>
<tr>
<td>- at 2 yrs</td>
<td>5.1 (0.9)</td>
<td>6.7 (1.1)</td>
<td>7.5 (1.2)</td>
<td>&lt;0.001*↑↑</td>
</tr>
<tr>
<td>- mean change over 1 yr</td>
<td>1.15 (0.78)</td>
<td>2.77 (1.03)</td>
<td>3.50 (1.05)</td>
<td>&lt;0.001*↑↑</td>
</tr>
<tr>
<td>- mean change over 2 yrs</td>
<td>1.15 (0.71)</td>
<td>2.71 (1.12)</td>
<td>3.56 (1.14)</td>
<td>&lt;0.001*↑↑</td>
</tr>
<tr>
<td>Photopic pupil size (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- at 1 yr</td>
<td>5.6 (0.8)</td>
<td>7.0 (1.0)</td>
<td>7.7 (1.0)</td>
<td>&lt;0.001*↑↑</td>
</tr>
<tr>
<td>- at 2 yrs</td>
<td>5.5 (0.8)</td>
<td>6.9 (1.0)</td>
<td>7.8 (1.1)</td>
<td>&lt;0.001*↑↑</td>
</tr>
<tr>
<td>- mean change over 1 yr</td>
<td>0.91 (0.78)</td>
<td>2.42 (0.91)</td>
<td>3.11 (1.08)</td>
<td>&lt;0.001*↑↑</td>
</tr>
<tr>
<td>- mean change over 2 yrs</td>
<td>0.74 (0.75)</td>
<td>2.25 (1.01)</td>
<td>3.11 (1.10)</td>
<td>&lt;0.001*↑↑</td>
</tr>
</tbody>
</table>

Chia et al, 2012
## Atropine: Side Effects

<table>
<thead>
<tr>
<th>Adverse events</th>
<th>A 0.01% (n = 84)</th>
<th>A 0.1% (n = 155)</th>
<th>A 0.5% (n = 161)</th>
<th>Exact Test P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allergic conjunctivitis</td>
<td>0/0 (0)</td>
<td>7/6 (4)</td>
<td>7/7 (4)</td>
<td>0.16</td>
</tr>
<tr>
<td>Dermatitis involving eyelids</td>
<td>0/0 (0)</td>
<td>2/1 (1)</td>
<td>4/3 (2)</td>
<td>0.54</td>
</tr>
<tr>
<td>Styel/chalazion</td>
<td>2/2 (2)</td>
<td>16/12 (8)</td>
<td>16/12 (7)</td>
<td>0.22</td>
</tr>
<tr>
<td>Loss of distant BCVA &gt;1 line</td>
<td>11/11 (13)</td>
<td>20/20 (13)</td>
<td>13/13 (8)</td>
<td>0.38</td>
</tr>
<tr>
<td>Others, eye related</td>
<td>2/1 (1)</td>
<td>2/2 (2)</td>
<td>3/3 (2)</td>
<td>1.00</td>
</tr>
<tr>
<td>Others, non–eye related</td>
<td>306/69 (82)</td>
<td>470/122 (78)</td>
<td>477/132 (82)</td>
<td>0.73</td>
</tr>
<tr>
<td>Severe adverse events</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Events requiring hospitalization</td>
<td>1/1 (1)</td>
<td>3/3 (2)</td>
<td>3/3 (2)</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Chia et al, 2012
Atropine Availability

- Compounding pharmacy required for 0.01% atropine
- Off-label use for myopia control
- Cost
Patient Management and Education

- All treatment options discussed are used off-label for myopia control as there are no FDA approved treatments for myopia control

- Informed consent

- Choose the most appropriate treatment option
  - Consider the impact on the patient’s vision, ocular health, and quality of life

- Set realistic expectations for the patient and patient’s parent(s)
Thank you!

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