Long-term corneal biomechanical results and histology
1, 4 and 8 months after WST-D and Near Infra-Red (NIR) treatment in rabbits

Jurriaan Brekelmans, Alexandra Goz, Alexander Brandis, Yoram Salomon, Mor Dickman, Rudy Nuijts, Avigdor Scherz, Arie Marcovich

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<table>
<thead>
<tr>
<th>Name</th>
<th>Financial Disclosure</th>
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<tr>
<td>Jurriaan Brekelmans</td>
<td>None</td>
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<tr>
<td>Alexandra Goz</td>
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<tr>
<td>Alexander Brandis</td>
<td>Steba-Biotech(P)</td>
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<td>Yoram Salomon</td>
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<td>Mor Dickman</td>
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<td>Rudy Nuijts</td>
<td>Abbot (S), Acufocus (S), Alcon (C, L, S),</td>
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<td>Asico (C, P), Bausch &amp; Lomb (S), Carl-Zeiss</td>
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<td>(S), HumanOptics (S), Ophtec (S), Oculentis</td>
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<td>(S), PhysIOL (S), Gebauer (S), TheaPharma (C)</td>
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<td>Avigdor Scherz</td>
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<td>Arie Marcovich</td>
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Purpose

To determine long-term follow up safety and efficacy of WST-D/Near infrared (NIR) treatment for corneal stiffening
Introduction

WST-D

- Derived from bacteria; bacteriochlorophyll
- Systemic safety established (phase III clinical trial)
- Dextran 500kDa limits penetration to anterior $\sim 200\mu m$

Fig. 1  Structure of WST11
Ashur et al. (2009)
Introduction
Near Infrared Light

- Near Infrared light (NIR)
- Safe wavelength of 755nm
  - Non-toxic for patient and physician
  - 10mW/cm²
- No limitations in corneal thickness
- Deep penetration
  - Scleral stiffening for myopia

Fig. 2 Absorbance spectrum of WST11
Introduction
Near Infrared Light

Current study protocol:
• 20 minutes WST-D impregnation
• 30 minutes NIR irradiation at 10 mw/cm²
Irradiation dose: 18 J/cm²

Fig. 3 Norm irradiance values for thermal lesions for cornea and lens.
International Commission on Non-Ionizing Radiation Protection. Health Phys 1997;73
Methods
Treatment

- In vivo, New Zealand White (NZW) rabbits
- Treated at age of 3 months
- 4 groups, sacrificed:
  - 1 week after treatment (immature, n = 4)
  - 1 month after treatment (immature, n = 6)
  - 4 months after treatment (mature, n = 9)
  - 8 months after treatment (mature, n = 4)
- Contralateral eye served as control
Methods

Treatment

Full mechanical de-epithelialization
Methods

Treatment

Full mechanical de-epithelialization

20 minutes WST-D impregnation
Methods
Treatment

- Full mechanical de-epithelialization
- 20 minutes WST-D impregnation
- 30 minutes NIR irradiation
Methods

Treatment

Full mechanical de-epithelialization

20 minutes WST-D impregnation

30 minutes NIR irradiation

1 week

1 month 4 months 8 months

Histology

Strip extensiometry
Methods
Treatment

- **Full mechanical de-epithelialization**
- **20 minutes WST-D impregnation**
- **30 minutes NIR irradiation**
- **1 week**
- **1 month**
- **4 months**
- **8 months**

- **Histology**
- **Strip extensiometry**
## Results
**Pachymetry**

<table>
<thead>
<tr>
<th>Follow-up</th>
<th>Timepoint</th>
<th>n</th>
<th>Control</th>
<th>Treated</th>
<th>P-value</th>
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</thead>
<tbody>
<tr>
<td>1 Week</td>
<td>Pre-treatment</td>
<td>4</td>
<td>401.3 ± 16.0</td>
<td>399.5 ± 16.3</td>
<td>0.275</td>
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<td>Pre-extensiometry</td>
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<td>387.2 ± 31.4</td>
<td>395.5 ± 39.1</td>
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<tr>
<td>1 Month</td>
<td>Pre-treatment</td>
<td>6</td>
<td>378.8 ± 23.2</td>
<td>398.1 ± 41.2</td>
<td>0.380</td>
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<td>Pre-extensiometry</td>
<td>6</td>
<td>387.2 ± 31.4</td>
<td>395.5 ± 39.1</td>
<td>0.436</td>
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<tr>
<td>4 Months</td>
<td>Pre-treatment</td>
<td>9</td>
<td>411.7 ± 22.3</td>
<td>411.9 ± 23.4</td>
<td>0.842</td>
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<td>Pre-extensiometry</td>
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<td>426.1 ± 21.1</td>
<td>422.8 ± 28.6</td>
<td>0.645</td>
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<tr>
<td>8 Months</td>
<td>Pre-treatment</td>
<td>4</td>
<td>355.5 ± 5.4</td>
<td>363.8 ± 7.8</td>
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<td>Pre-extensiometry</td>
<td>4</td>
<td>399.8 ± 20.4</td>
<td>422.1 ± 24.2</td>
<td>0.087</td>
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</tbody>
</table>

Table 1. Corneal pachymetry ± SD (in μm).
Results
Biomechanical Results

Table 2. Mean elastic modulus ± SD (in MPa).

<table>
<thead>
<tr>
<th>Follow-up</th>
<th>n</th>
<th>Control</th>
<th>Treated</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Month</td>
<td>5</td>
<td>9.6 ± 3.6</td>
<td>16.0 ± 2.3</td>
<td>0.008</td>
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<td>4 Months</td>
<td>7</td>
<td>12.6 ± 2.3</td>
<td>18.1 ± 4.5</td>
<td>0.003</td>
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<td>8 Months</td>
<td>3</td>
<td>14.2 ± 3.6</td>
<td>18.6 ± 3.6</td>
<td>0.010</td>
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</table>

Fig 2. Boxplot of elastic modulus per protocol and follow-up. Dashed line indicates overall mean after treatment.
## Results

### Keratocyte Count

<table>
<thead>
<tr>
<th>Region</th>
<th>n</th>
<th>Control</th>
<th>Treated</th>
<th>P-value</th>
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<tbody>
<tr>
<td>Anterior</td>
<td>4x5</td>
<td>19.0 ± 4.1</td>
<td>1.5 ± 1.7</td>
<td>0.002</td>
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<tr>
<td>Middle</td>
<td>4x5</td>
<td>12.8 ± 1.6</td>
<td>12.1 ± 2.0</td>
<td>0.640</td>
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<td>Posterior</td>
<td>4x5</td>
<td>12.9 ± 0.9</td>
<td>14.4 ± 3.2</td>
<td>0.463</td>
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### 1 Week:

### 8 Months:

<table>
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<th>Region</th>
<th>n</th>
<th>Control</th>
<th>Treated</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>3x5</td>
<td>14.5 ± 2.5</td>
<td>15.9 ± 1.1</td>
<td>0.562</td>
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<tr>
<td>Middle</td>
<td>3x5</td>
<td>11.2 ± 1.8</td>
<td>12.1 ± 4.1</td>
<td>0.810</td>
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<tr>
<td>Posterior</td>
<td>3x5</td>
<td>11.2 ± 0.9</td>
<td>12.4 ± 1.5</td>
<td>0.355</td>
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</table>
Conclusion

- Long term stiffening, from young age until after maturation.
- Repopulation of keratocytes has occurred after 8 months
- Alternative for thin corneas
Thank You for Your Attention

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