Pseudoaccommodation of WIOL CF Hydrogel Lenses

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Statement of Financial Interest

- The presenting author has no financial interest in the subject matter of the following presentation.
- The co-authors have financial interest in the subject matter of the following presentation.
- WIOL CF – hydrogel IOL is approved for commercial use in EU but has not been approved by the FDA yet.
WIOL-C/CF “Full Optics”
Plano-Convex hydrogel IOL in hydrate state
1992 - 2006
WIOL C/CF “Full Optics”
Plano-Convex hydrogel IOL
1992 - 2006

MENISCOID ANTERIOR SURFACE

O.D. – 8.6 – 9.0 mm

C.T. = 1.1-1.4 mm

HYPERBOLOID SURFACE CONTACTING POSTERIOR CAPSULE
WIOL-C/CF edge profile

- Meniscoid anterior surface
- Conical facet
- Hyperboloid surface contacting posterior capsule
- Optical transition zone
- Sharp edge
HYPERBOLIC POLYFOCAL OPTICS

- Anterior surface: monofocal spherical
- Posterior surface: polyfocal hyperbolic
- Lens is polyfocal with refractive power decreasing from center to periphery
WIOL MAIN FEATURES:

- Large optical zone > 8.6 mm
- A constant = 120
- High water content > 41 %
- Excellent biocompatibility
- Negatively charged surface
- Implantable through 2.6 mm incision now
- Plasticized for implantation (CF model)
- Elastic properties with delayed recovery (“lazy rubber”) 
- Grows and softens in the implanted state

WIOL-CF seven years after implantation
(Co-author’s left eye in 2006)

- Surgery since 1994/1995
- 67 eyes, 61 patients
- Age ranging from 75 to 92 years
- Surgery performed through 7+mm sclerocorneal tunnel
- WIOL implanted without folding in hydrated state
## Range of Pseudo-Accommodation (P/A)

### Near Vision (WIOL-C)

(Re-counted from Near Point Examination)

<table>
<thead>
<tr>
<th>Level of P/A (Dpt.)</th>
<th>BCVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20/20-20/30</td>
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<tr>
<td>0.5</td>
<td>0</td>
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<tr>
<td>1.0</td>
<td>5 (7.5%)</td>
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<tr>
<td>1.5</td>
<td>16 (24%)</td>
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<tr>
<td>2.0</td>
<td>20 (30%)</td>
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<tr>
<td>2.5</td>
<td>6 (9%)</td>
</tr>
<tr>
<td>3.0</td>
<td>1 (1.5%)</td>
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**Defocusing Limit Far Vision (WIOL-C)**

(Level of under-correction for reaching the same VA as the best one)

<table>
<thead>
<tr>
<th>Defocusing limit (Dpt.)</th>
<th>BCVA</th>
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<tr>
<td>0.5</td>
<td>1 (1.5%)</td>
</tr>
<tr>
<td>1.0</td>
<td>5 (7.5%)</td>
</tr>
<tr>
<td>1.5</td>
<td>14 (21%)</td>
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<tr>
<td>2.0</td>
<td>19 (28%)</td>
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<tr>
<td>2.5</td>
<td>6 (9%)</td>
</tr>
<tr>
<td>3.0</td>
<td>5 (7.5%)</td>
</tr>
</tbody>
</table>
WIOL CF Study Group I:

- Surgery from 1999 to 2004
- 22 eyes (16 patients)
- Age ranging from 62 to 82 years
- No macular pathology
- Surgery performed through 5mm sclerocorneal tunnel
- Folded WIOL CF implanted in plasticized state by folding forceps
UCVA, BCVA and Induced Astigmatism

(2 years and more)

- UCVA = 0.7
- BCVA = 0.8 (range from 0.66 to 1.0)
- Average induced astigmatism 0.49 D
Average Pseudo-Accommodation range

(2 years and more)

- Mean value = 1.75 Dpt

- Inter-individually differences

- In success, pseudo-accommodative range is more than 2 Dpt, in opposite case (inactive people)
  - up to 0.5 Dpt
WIOL CF Study Group II:

- Surgery from 2004 to 2005
- 26 eyes (19 patients)
- Age ranging from 54 to 80 years
- No macular pathology
- Surgery performed through 2,6mm corneal tunnel
- Folded WIOL CF implanted in plasticized state by Medicel injector (cartridge 2,2mm)
- AC constant 118,0
Contemporary WIOL-CF Implantation
Average UCVA, BCVA, Induced Astigmatism and Correction
(1 year and more)

- UCVA = 0,65
- BCVA = 0,945 (range from 0.25 to 1,0)
- Average induced astigmatism 0,23D
- Average correction: +0,55
Average Pseudo-Accommodation Range

(1 year and more)

- 2.22 Dpt

- Inter-individually differences

- In success, pseudo-accommodative range is more then 2 Dpt, in opposite cases (inactive people) - up to 0.5 Dpt
WIOL CF Study Group III:

- Surgery from IX/05 – XII/05
- 24 eyes (22 patients)
- Age ranging from 50 to 71 years
- No macular pathology
- Surgery performed through 2,6mm corneal tunnel
- Folded WIOL CF implanted in plasticized state by Medicel injector (cartridge 2,2mm)
- AC constant changed to 120,0
Far Vision - Uncorrected Visual Acuity
Near Vision - Uncorrected Visual Acuity

![Bar Chart]

- J.No.7
- J.No.6
- J.No.5
- J.No.4
- J.No.3
- J.No.2
- J.No.1

1.day
1.week
1.month
Averaged Contrast Sensitivity Curve:

- Average levels of WIOL patients contrast sensitivity:
  - Worse than monofocal artefakia
  - Worse than average population limit
  - Better than cataractous eye
  - In lower age limit
Example of Usual Autorefractometer Examination of Pseudo-Accommodation:

<table>
<thead>
<tr>
<th>SPH</th>
<th>CYL</th>
<th>AX</th>
<th>UOL</th>
<th>UD</th>
<th>VOL</th>
<th>HEIGHT</th>
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<tr>
<td>-1.75</td>
<td>-1.25</td>
<td>121</td>
<td></td>
<td></td>
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<td>122</td>
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<td></td>
<td></td>
<td></td>
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</tbody>
</table>

0.5

1.75
UBM Images of Irido-Lental Area during the Pseudo-Accommodation.

Note Arching of Anterior WIOL-CF Surface by Pupil Sphincter Muscle Contraction.
UBM Images of Angular Region during Pseudo-Accommodation.

Note A-P Movement of the Angular Structures

44°  35°
Video-sequence of pseudo-accommodation by UBM (35 MHz)
Scheimpflug’s image of WIOL CF

Attempt to accommodate - no effect

Scheimpflug’s image – Pentacam, Oculus
PSEUDOACCOMMODATION OF WIOL-CF DUE TO PUPIL CHANGES:
Contraction increases refractive power and improves contrast sensitivity.
PSEUDO-ACCOMMODATION

subjective observations:

- Near focus improves by **good illumination** – (Contracted iris increases refractive power due to the hyperbolic optics)
- Acuity strongly **degrades** after **long work** on poor computer screens or long reading of low-quality print under poor light conditions – double vision, poor resolution, visual distortions (muscle fatigue?)
- Far focus improves and double vision disappears by **widely opening eyes** (Eyelid pressure? Increased optical zone/ decreased average refractive power?)
- Near focus improves by **narrowing eyes**
PSEUDO-ACCOMMODATION

more subjective observations:

- **Very near focusing requires conscious effort and time** (1 to 2 seconds lag – iris contraction? Ciliary apparatus in work? bulbus extension?)
- **Using both eyes improves both near and far focus**
- **No glare or other vision problems while driving at night**
- **No degradation of peripheral vision at driving, tennis, etc.**
- **No acuity deterioration after 4 years**

**In summary:**

WIOL-CF allows a comfortable everyday life and work or sports activities without use of spectacles or contacts
WIOIL-CF PSEUDO-ACOMMODATION
possible mechanisms:

- **Polyfocal optics** (instantaneous action, effortless, contrast degradation)

- **Lens A-P movement** due to the action of ciliary body and positive vitreous body pressure (natural accommodation apparatus, automatic reaction - does not require conscious effort, short reaction time)

- **Lens arching** due to ciliary mussel action

- **Pupil changes** causing refractive changes of active optical area
Conclusions

- Pseudo-accommodation of WIOL CF appears to be caused by a combination of multiple factors, i.e. A-P movement, polyfocal optics, pupil size changes and optics deformation.
- Relative contributions to pseudo-accommodation are not yet fully understood.
- WIOL-CF is potential IOL for all possible forms of RLE, young and active people, cataract surgery, and vitreo-retinal patients with cataract.
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