MVZ PROF. NEUHANN
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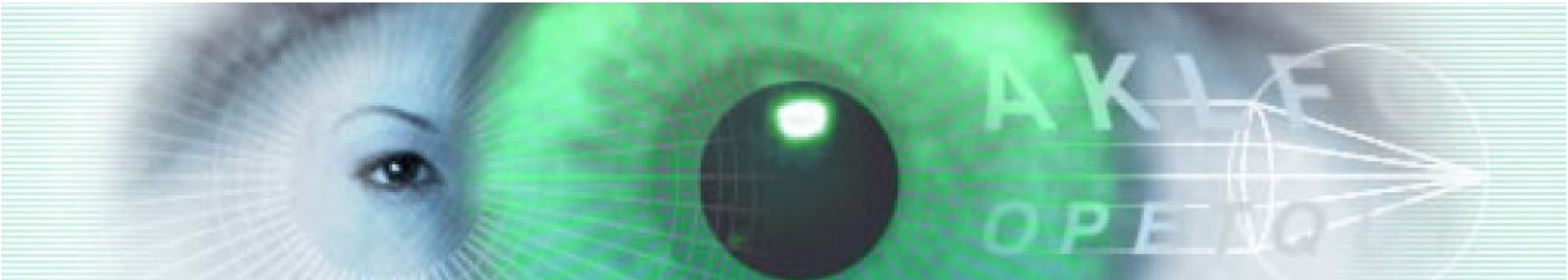
Customized patient care

First clinical outcomes with a novel monofocal intraocular lens for individual spherical aberration correction

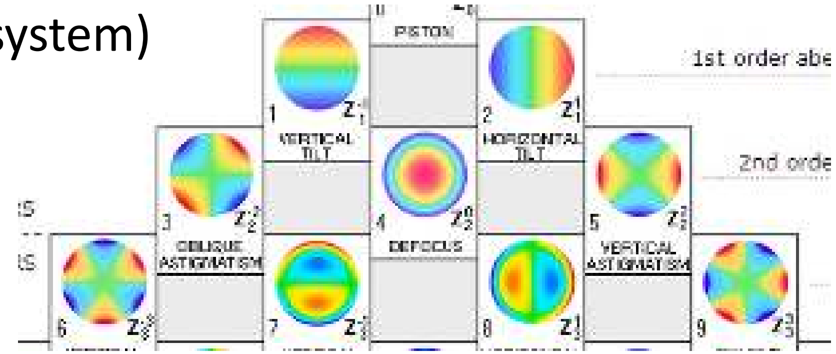
Thomas Neuhann | **Munich**



Imperfections of optical systems
Optical aberrations

- Spherical aberration
- Chromatic aberration
- Astigmatism of oblique bundles
- Coma

Impair ideally punctual imaging of lens (system)
even with optimal nominal refraction

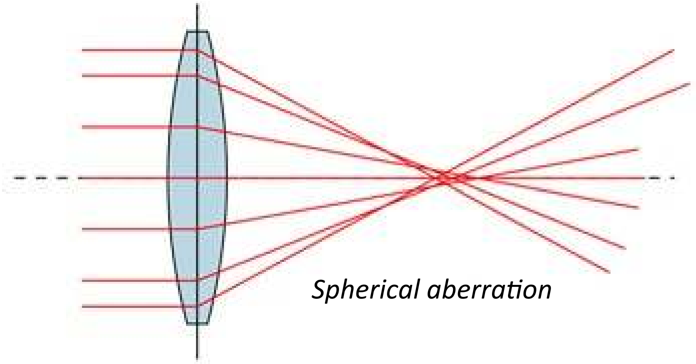


Can only be corrected on the surface
On which they originate
Exception: Rotationally symmetric aberrations
- Spherical aberration
- Chromatic aberration

CORRECTING SPHERICAL ABERRATION (SA)

Spherical aberration - SA - is

- Major relevance for image quality
- Rotationally symmetrical - therefore
- Correctable by aspheric surface



Advantages of correcting SA

- Optimizing corrected visual acuity[1,2]
- Enhanced photopic contrast sensitivity[1-4,7,8]
- Enhanced mesopic contrast sensitivity[1-9]
- Reduction of photic phenomena[10]
- *Enhanced depth of focus ?*

→ Increased functional quality of vision
… especially in reduced lighting conditions

Image: https://en.wikipedia.org/wiki/Spherical_aberration

CORRECTING SPHERICAL ABERRATION (SA)

With lens exchange surgery – for cataract or refractive indication – we have a unique chance to not only optimize target refraction, but also imaging quality by correction of SA

- of contributing optical surfaces only the cornea remains
- the lens – IOL – can be used for both corrections

High inter-individual variability of corneal SA

„ONE FITS ALL“?

Is better than none – but not as good as possible...

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Solution:
individual spherical aberration correction

… using INVIDUA® IOL (Human Optics)

- **Individual-aberration correcting** anterior surface geometry
- Based on **ASPIRA-aA** (HumanOptics AG)
- Monofocal, aspherical
- HD-optic through sub-nano resolution technology
- 360° LEC barrier
- Hydrophilic acrylic
- 6.0 mm optic diameter
- 12.5 mm total diameter
- MICS (sub 2.0 mm)

INVIDUA®-aA IOL

Prospective Multicenter Study

Aims

- **Proof** that corneal SA can be reduced to a minimum with individual aberration correcting INVIDUA IOL

  Target total SA = 0.0 µm

- **Comparison of functional parameters with** a control group with aberration neutral lenses of otherwise identical lens design (Aspira-aA IOL)

Prospective Multicenter Study

Inclusion criteria:

- Cataract patients
- Unimpaired vision prognosis ≤ 0.1 (logMAR)
- No previous eye surgery

Exclusion criteria:

- Corneal astigmatism ≤ 1.0 D
- No other ocular disease

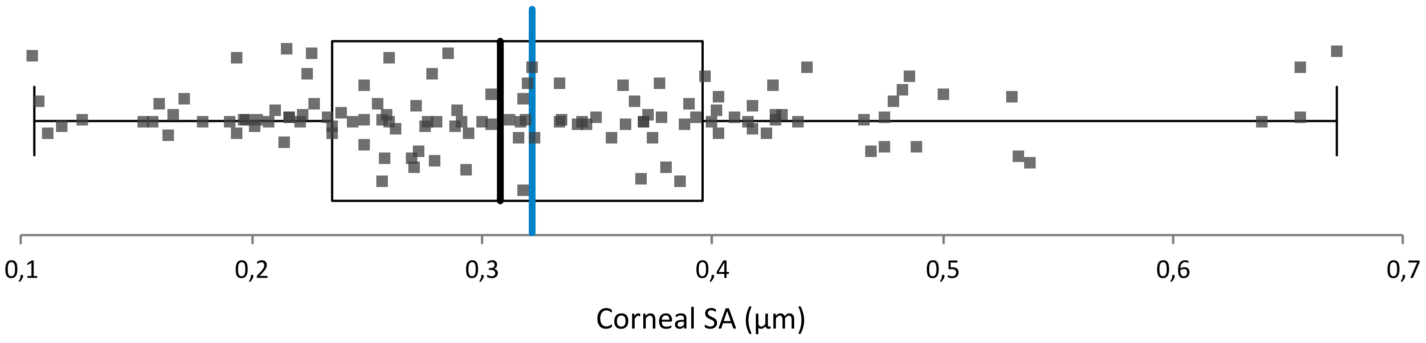
Prospective Multicenter Study

Main Outcome

- Uncorrected and corrected distance visual acuity: 100 cm, 63 cm, 40 cm (ETDRS Charts)
- Subjective refraction
- Tomography (Pentacam, Oculus)
- Wavefront (iTrace, Tracey Technologies)
- Defocus curve
- Contrast sensitivity under photopic (85 cd/m²) and mesopic conditions (3 cd/m²), with and without glare (Functional Vision Analyzer, Stereo Optical)

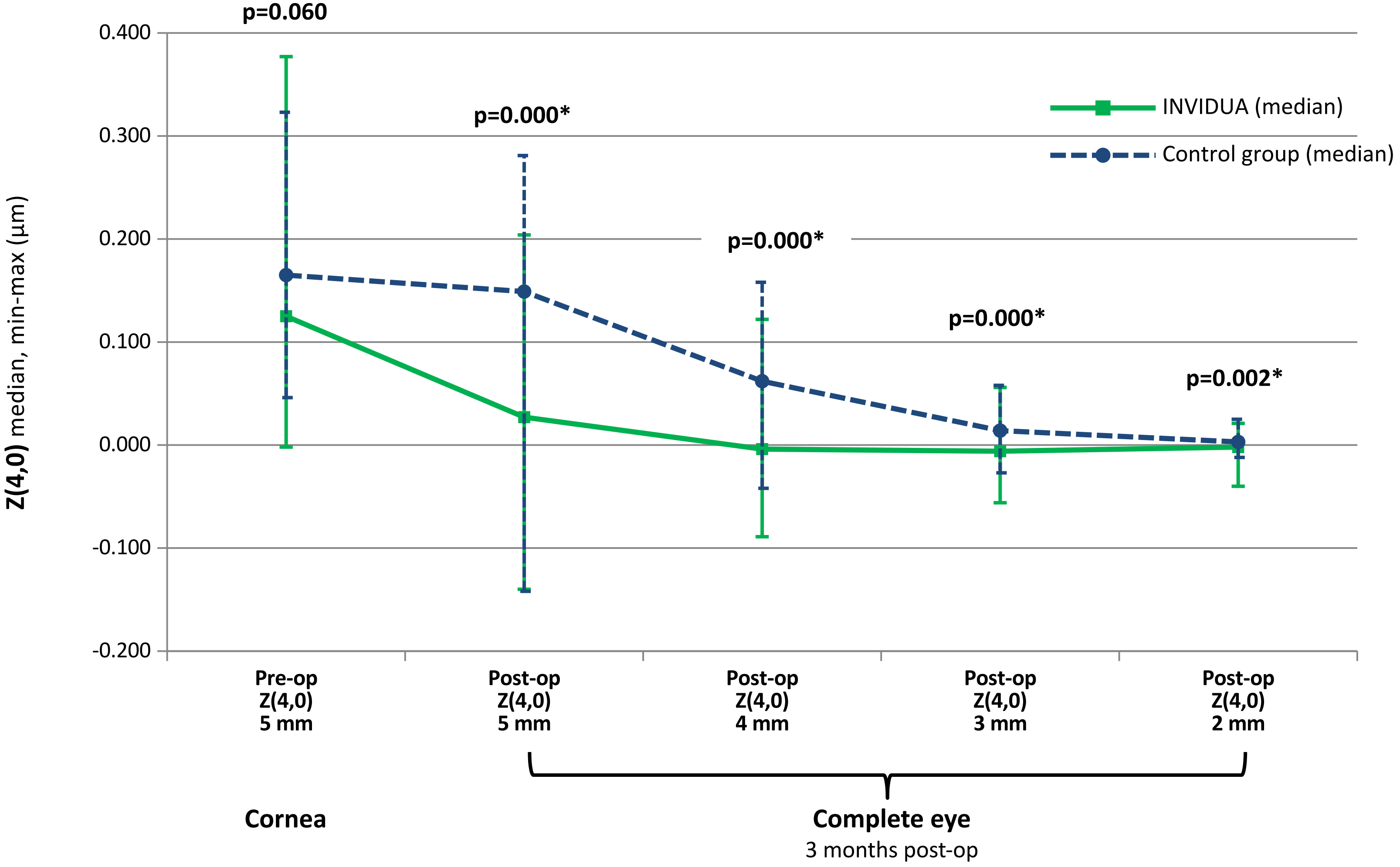
Prospective Multicenter Study

- Included Patients
  - 92 Individua,
  - 41 control group
- No significant differences between groups in
  - Gender
  - Age
  - Axial length
  - SA (Z4/0) – 6 mm zone



Results

Spherical aberration pre- vs. postoperative



* statistically significant difference between both groups (p ≤ .05); Mann-Whitney-U test

Results

Uncorrected distance visual acuity - monocular

VISUAL ACUITY (logMAR) 3 months postoperative		INVIDUA	Control group	p
Distance				
	Mean ± SD	0.01 ± 0.08	0.07 ± 0.12	
	Median	**0.00**	**0.00**	*.011**
	Range	0.22 bis -0.10	0.52 bis -0.10	
100 cm				
	Mean ± SD	0.13 ± 0.14	0.15 ± 0.16	
	Median	**0.10**	**0.10**	*.854*
	Range	0.40 bis -0.10	0.60 bis -0.10	
63 cm				
	Mean ± SD	0.24 ± 0.16	0.25 ± 0.17	
	Median	**0.30**	**0.20**	*.993*
	Range	0.80 bis -0,10	0.70 bis 0.00	
40 cm				
	Mean ± SD	0.45 ± 0.18	0.45 ±0.18	
	Median	**0.49**	**0.40**	*.674*
	Range	0.92 bis 0.00	0.80 bis 0.10	

* statistically significant difference (p ≤ .05); Mann-Whitney-U test

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Results

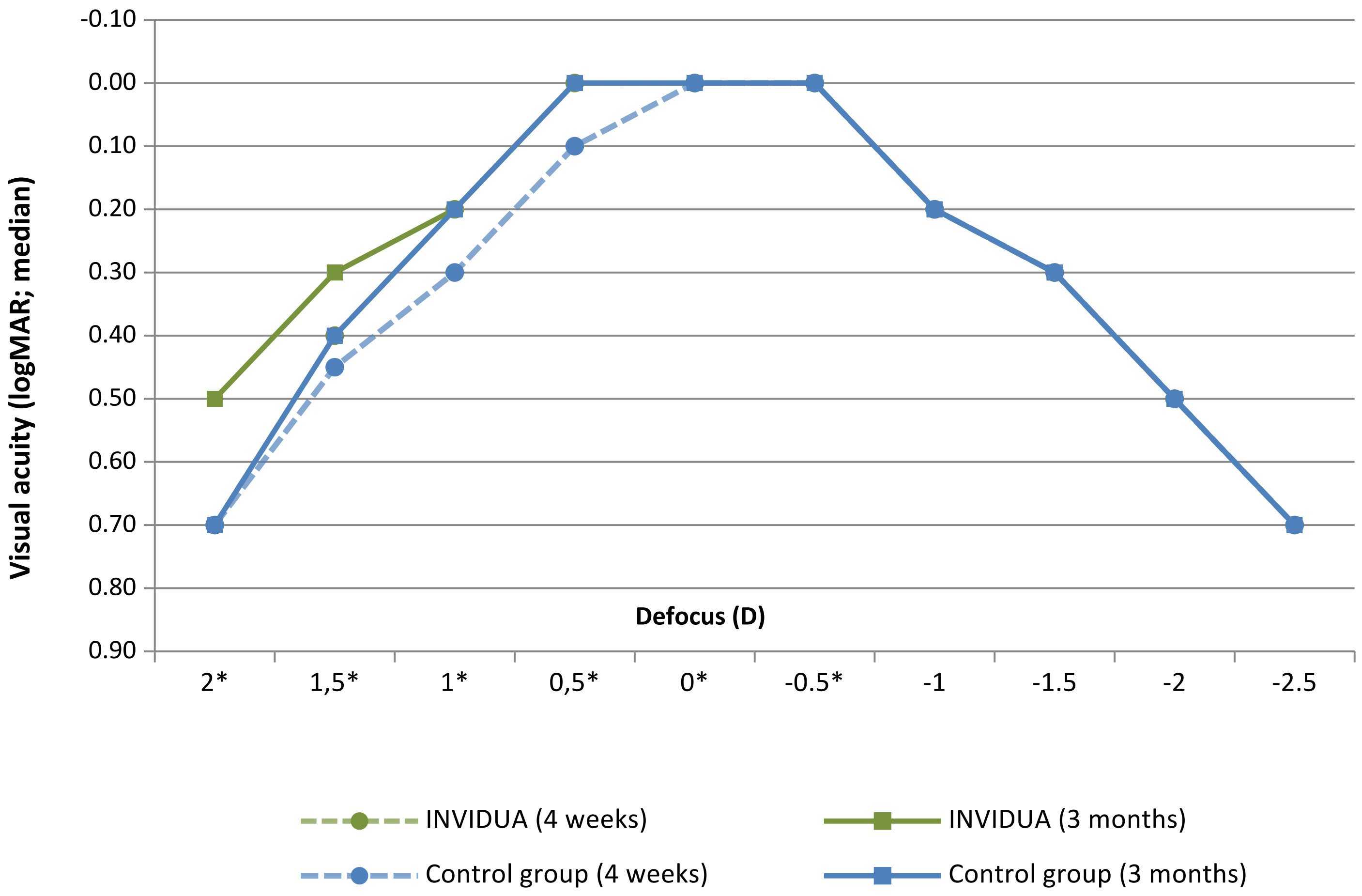
Corrected distance visual acuity - monocular

VISUAL ACUITY (logMAR) 3 months postoperative		INVIDUA	Control group	p
Distance				
	Mean ± SD	-0.03 ± 0.05	-0.00 ± 0.03	
	Median	**0.00**	**0.00**	*.001**
	Range	0.05 bis -0.18	0.10 bis -0.10	
100 cm				
	Mean ± SD	0.09 ± 0.11	0.12 ± 0.11	
	Median	**0.10**	**0.10**	*.137*
	Range	0.30 bis -0.10	0.40 bis -0.10	
63 cm				
	Mean ± SD	0.22 ± 0.13	0.23 ± 0.14	
	Median	**0.20**	**0.20**	*.995*
	Range	0.49 bis -0.10	0.60 bis 0.00	
40 cm				
	Mean ± SD	0.42 ± 0.15	0.41 ± 0.15	
	Median	**0.40**	**0.40**	*.640*
	Range	0.80 bis 0.10	0.70 bis 0.10	

* statistically significant difference ($p \leq .05$); Mann-Whitney-U test

Results

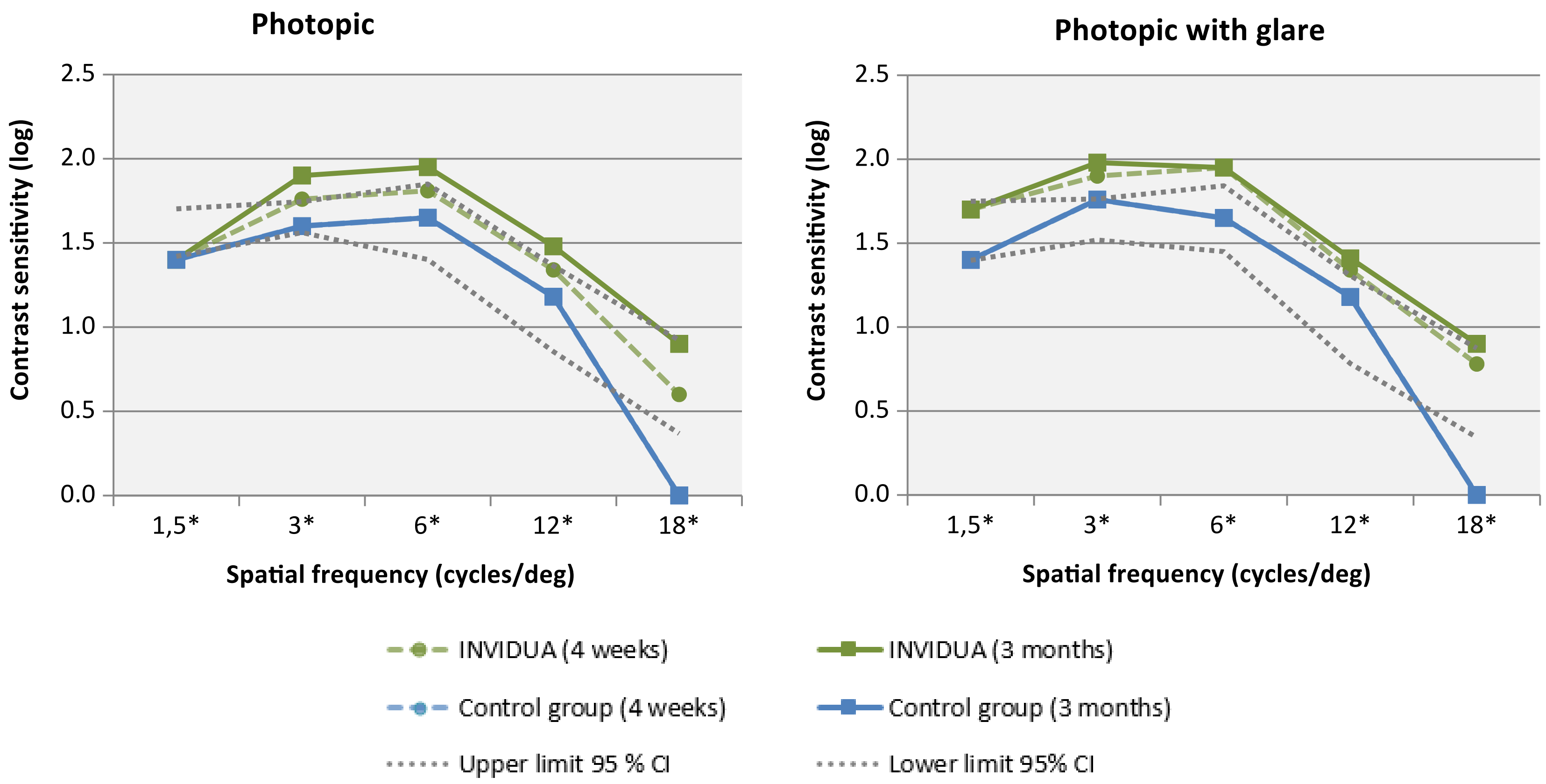
Defocus curve - monocular



* statistically significant difference between both groups 3 months postoperative (p ≤ .05); Mann-Whitney-U test

Results

Contrast Sensitivity - monocular, without correction



* statistically significant difference between both groups 3 months postoperative (p ≤ .05); Mann-Whitney-U test

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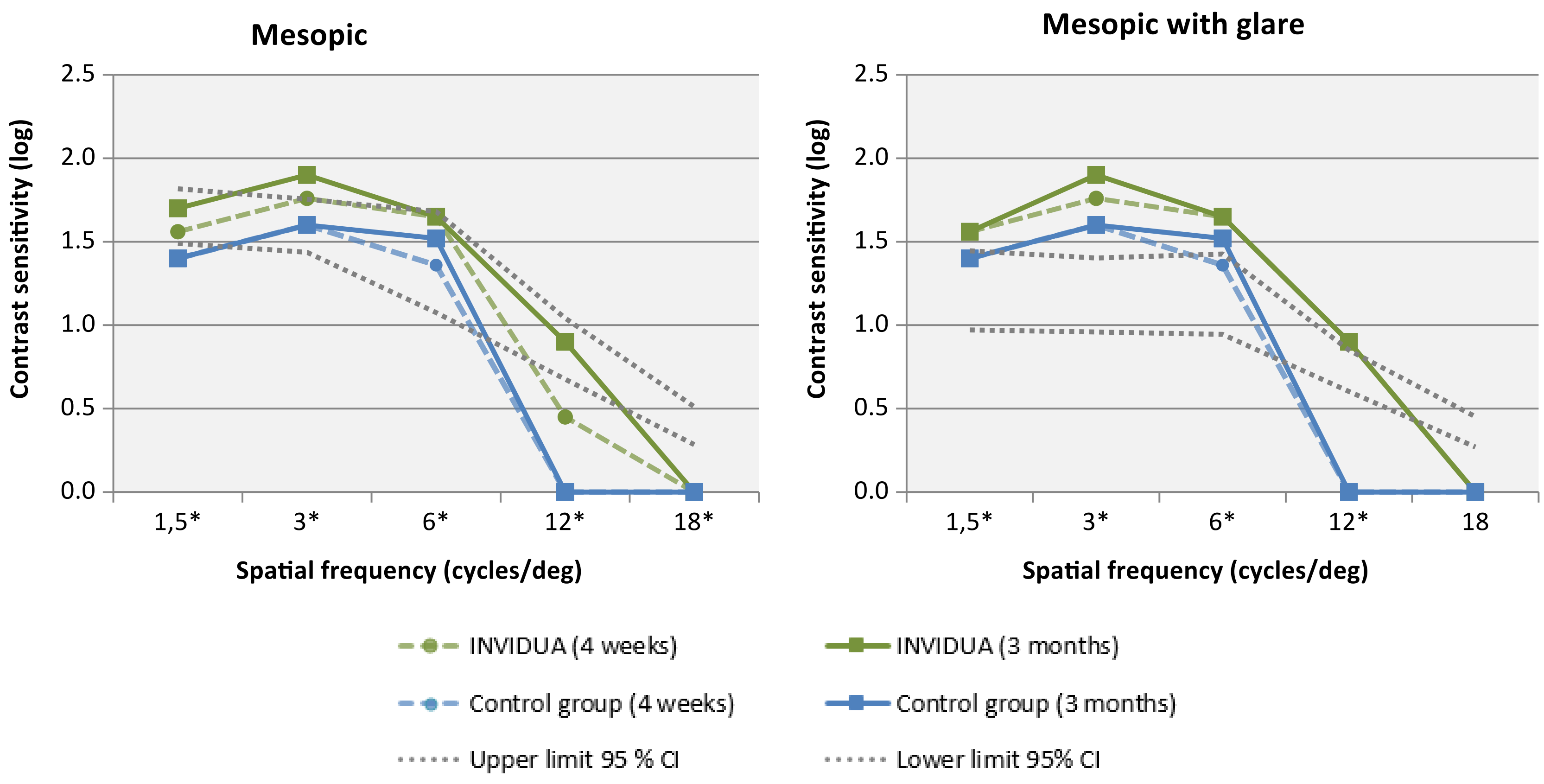
Results

Contrast Sensitivity - monocular, without correction



* statistically significant difference between both groups 3 months postoperative ($p \leq .05$); Mann-Whitney-U test

Conclusion - 1

- ✓ **Individual reduction of SA to a minimum was reached with INVIDUA IOLs**

➡ **with the consequence, that patients in the INVIDUA-group achieved**

- ✓ **A significantly higher distance visual acuity (uncorrected and corrected)**
- ✓ **A significantly higher contrast sensitivity at nearly each spatial frequency (photopic, mesopic, with and without glare)**
- ✓ **A significantly higher visual acuity with +0.50 to +2.00 D defocus**

Conclusion - 2

Orthodoxy / physics say: More depth of focus
needs more aberration
costs MTF

Our results show: Depth of focus
can be obtained with *minimization* of aberration
with *optimization* of MTF

Conclusion: Vision is more than physical optics:
Neurophysiological image processing is major part of good vision with depth of focus


Thank you!

LITERATURE

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