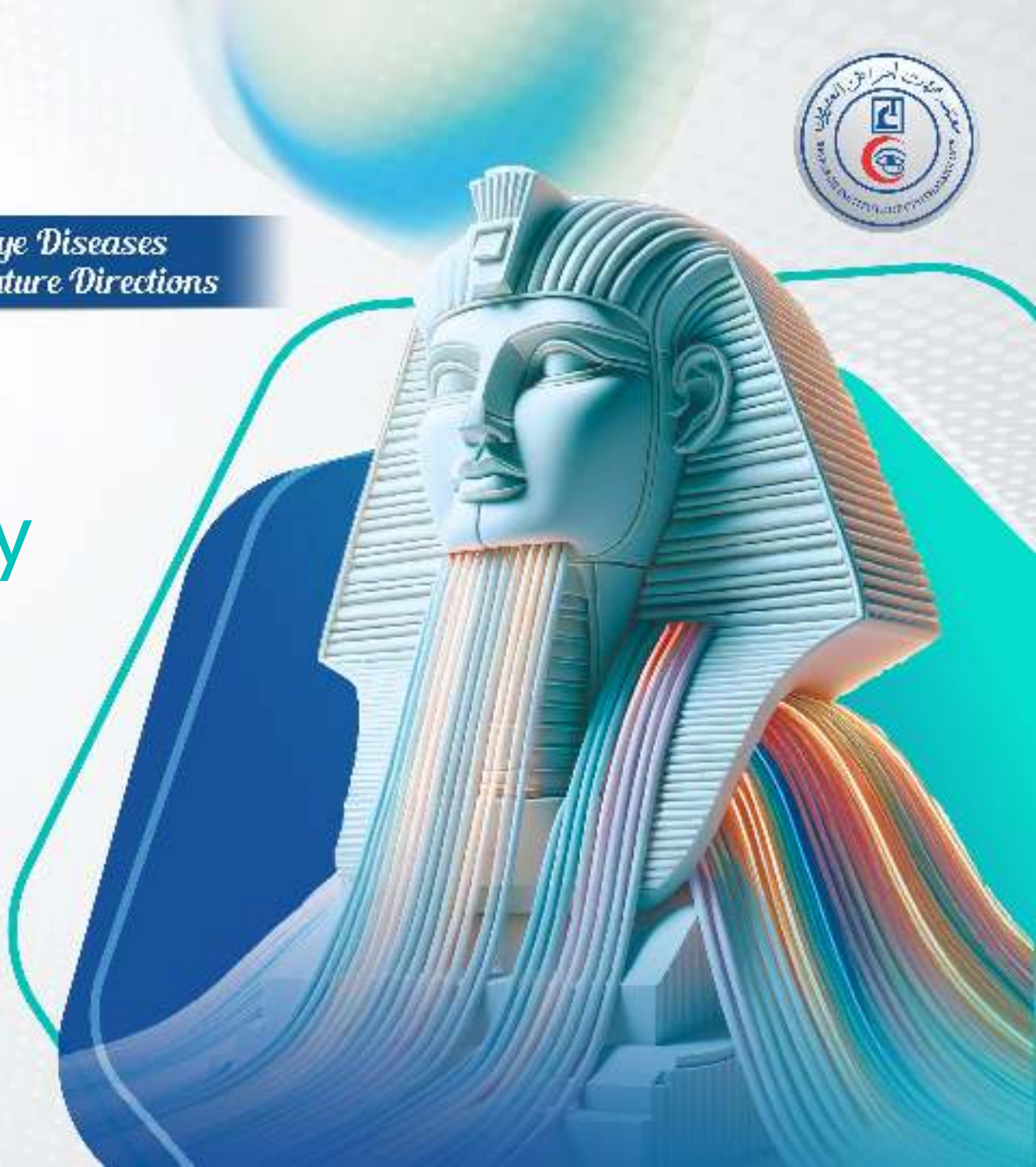
17 TH INTERNATIONAL CONFERENCE OF THE RESEARCH INSTITUTE OF OPHTHALMOLOGY

RIO 2025

Anterior Segment Eye Diseases
Current Status & Future Directions



Thoughts to find your way through the jungle of different IOL options

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Plenty of options....

- Materials
  - Acryl hydrophilic vs. hydrophobic
- Haptics
  - 3- vs 1-piece
  - Open-C-loop vs. closed loops vs plate-haptic
- Optics
  - Spherical vs. zero-aspheric vs. correcting negativ-aspheric; achromatic
  - Monofocal vs. EDOF vs. bi-/trifokal vs. pinhole
  - EDOF
    - numerous optical principles – diffraktive, different surface curvatures for focus-elongation
  - Bifocal
    - Diffraktive vs. segmental
  - Trifocal
    - classically diffraktive, sinusoidal diffraktive, apodised ...
  - Blue- or violet- filters

Criteria for choice: What should the lens provide?

- Lifelong durability/stability – remain transparent
  - Endure potential later additional surgical interventions
- Easy implantation, solid centered position, easy explantion if needed
  - Also with ruptured capsule
- Prevention of potential damaging factors
  - Filter potentially damaging wavelenths of light
- Optimal imaging quality
  - In combination with the other optical media = cornea!
  - Optimal depth of focus – i.e. requiring as little additional optical correction as possible

Durability – Transparency: Material

- Hydrophilc Acrylates
  - „Spontaneous“ opacification
    - Certain brands – after different time intervals
  - Opacification (calcification) after surgery with air/gas filling
    - Described practically only with hydrophilic materials
- Hydrophobic Acrylates
  - „Glistening inclusions“
    - Increasing over time
    - Frequency and extent brand-dependent
    - Funktional relevance dicussed controversely ....

Durability – Transparency: Material

my personal preference

- Hydrophilic Acrylate
  - No objection, if later additional intervention with air/gas-tamponade is not to be anticipated
  - If other advantages justify
  - Only brands with never reported opacifications
- Hydrophobic Acrylates
  - No brands with reported „glistenings“ (!)
    - Especially if increasing over time
    - If later additional intervention with air/gas-tamponade is potentially expectable (e.g. guttata...)
    - No extra advantage with hydrophilic alternatives
    - „When in doubt“

Haptics
my personal preference

- Open over closed
  - Explantation easier
  - Flexible fitting to capsular bag diameter
  - With toric IOL frosted or plate-haptic
- 3-piece vs. 1-piece
  - In capsular bag equivalent – other properties more important
  - For sulcus only 3-piece
- Diameter
  - Capsular bag 12-13 mm (flexible open/c-shape!)
  - Sulcus 14 mm –

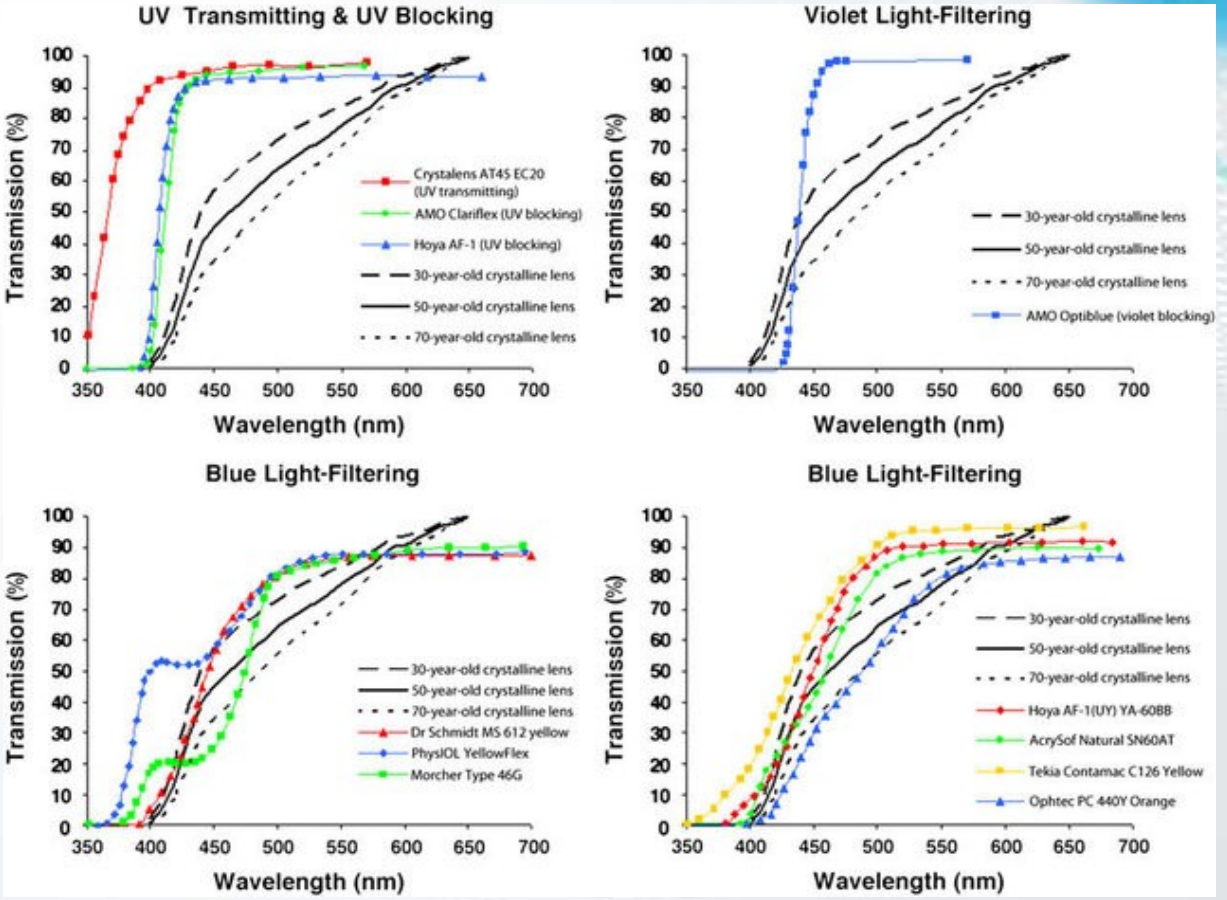
But nota bene: combination options limited !!

Damage prevention wavelength filters

- Idea:
  - Lipofuscin in pigment epithelium increases over lifetime
  - Lipofuscin absorbs short = high-energy wavelenths strongly
  - Leads to increased formation of oxygen radicals
  - Increases risk for damage of PE and photoreceptors ➡ ***AMD***
  - Filtering of short wavelengths protects
- Welcome additional effect
  - Straylight increases with shorter wavelengths
  - Filtering diminishes straylight – less glare
- Theoretical disadvantages
  - Colour perception
  - Circadian rhythm disturbance (pineale melatonin-secretion suppressed by blue light ...)

Damage prevention wavelength filters

- UV
  - All IOLs
- Violett
  - Tecnis IOL von Pharmacia -> J&J
  - Absorption 420 – ca 450 nm
- Blue
  - Many brands
  - Different apsorption spectra
  - All ± like natural lens



Damage prevention – wavelength filters *Data*

- AMD-Protection
  - To date no study could clearly prove such protection(!)
    - comparison clear vs blue-filter-lenses
    - Suits AREDS: Cataract-surgery does not influence AMD-progression – as opposed to earlier Studies (Beaver Dam, Blue Mountains)
- Straylight-/Glare“Protection“
  - Some studies show less subjective glare with multifocal IOL
- Circadian rhythm – sleep behaviour
  - No data for such influence
  - Not to be expected, since absorption ± equal to natural lens
- Colour perception
  - No data for such influence
  - Not to be expected, since absorption ± equal to natural lens

Damage prevention – Wavelength filters *my personal preference*

In general: Patient decides after short understandable information

If I am asked „What would you select for yourself?“

- With a (high) risk macula situation: Blue-filter
  - Extra Chance without extra risk
- With intermediary risk situation (zB hereditary), und tendency „to err on the safe side“ : Blue- or violet-Filter according to selected IOL
- Without increased risk and wish for optimal function: Violet-Filter or clear.

Optimal Image quality

- Every optical system has imaging aberrations
  - Spherical Aberration
  - Chromatic Aberration
  - Astigmatism of oblique bundles
  - Coma

  „Orders“ do not exist for aberrations – but for mathematically describing equation systems...
- On a plane different from the plane of their origin only rotationally symmetric aberrations can be correted
  - Spherical and chromatic aberration
  - Both – esp.spherical – contribute to a high degree to the total aberration(s)
- For optimal image quality the entire optical system must be taken into account
  - In the eye: cornea and lens/IOL

Optimal Image quality

- “Normal “ EYE
  - Cornea: Positive SA ± constant over lifetime
  - Lens: From negative SA in youth continuously changing to positive SA with age
- IOL-Options
  - Spherical: *Increases* total positive SA (+ cornea!)
  - Aspheric SA-free: Limits total SA to that of cornea
  - SA-correcting: *Improves* total SA
    - Standard values different models (-0,11 – -0,17 – -0,24µ)
    - Individually
  - CA-correcting
    - Only one model
  - Toric

➡ *Cave: Optimized Imaging does NOT decrease depth of focus!!*

Optimal Image quality
Data

- Aberration-correcting IOL
  - Individually SA-correcting vs. SA-neutral IOL*)*
    - Significantly better contrast sensitivity
    - Significantly better CDVA
    - No inferior DOF – in one distance even better!
  - With standard SA-correction
    - Contrast sensitivity better than spherical OL
    - Results depending on stiudy design / control group

Optimal Image quality
My personal preference

- With monofocal IOL

  SA correcting IOL:

  - No reasonalble argument for suboptimal image quality
    - Cost???
  - Individual correction currently not available
  - Therefore selection according to individually measured corneal SA (e.g. pentacam) among the available models as closest to the ideal asphericity

- With „multifocal“ IOL

  Best possible optimization of optics by

  - Best availalble SA-correction
  - CA correction
  - Minimization of straylight by short-wavelength filtration kurzer Wellenlängen
  - *NB: Very limited combination-choicesl!!*

Optimal Depth of Focus

- Binocular: Monovision
  - Variable Extent
- Monocularly (binocularly „enhanced“)
  - Bifocal –
    - diffractive
    - refractive
  - Trifocal – diffraktive
    - Different techniques
  - EDOF (Enhanced Depth Of Focus)
    - „wavefront-modulating“ – „Enhanced monofocal“
    - Diffractive
  - Pinhole
    - IC8
  - *„Accommodiating“*
    - *Old dream – all options hitherto : First hyped - then silently dissappeared…*

Optimal Depth of Focus

- Monovision – (different extent)

Advantage:

- Image quality unimpaired for each eye
- Extent variably selectable
- Disadvantage of inter-eye-differencesituationally correctable (e.g. driving at night)
- CAN BE TRIED/TESTED

Disadvantage

- Inter-eye difference
- Stereopsis-reduction (according to extent)

- IC 8 – pinhole

Advantage:

- No image deterioration

Disadvantage

- Dark adaptation reduced
- Fundusscopy impaired (IR-transparent)
- Disadvantage not correctable

- EDOF

Advantage:

- Binocular balance – inkl. summation
- Deterioration of image quality/photic phenomena limited
- Increase of DOF by mini-monoviwsion possible

Disadvantage:

- Near distance limited despite worse image quality
- Disadvantage not correctable

- Trifo

Advantage:

- Binocular balance – inkl. summation
- Full range D – I - N

Disadvantage

- Loss of contrast and image quality
- Photic phenomena – glare, halos
- Disadvantage not correctable

Optimal Depth of Focus

Fundamental „Problem“

Everything is a compromise!!

All extensions of DOF „cost“ Image quality

The more DOF, the more compromise between as little additional correction as possible and as optimal as possible vision in all distances

The choice of the ideal compromise is maximally individual:

„Optimal success is highly dependent on ideal patient selection“

- But nobody clearly says, how to do that .....
- You have to describe to the patient– an optical layperson! – in words a visual impression, so that s/he can have a realistic imagination, how this will individually subjectively be perceived
- The describer – physician – must describe a visual impression, which one has never had oneself
- Simulations are only available very limitedly and basically limited to theoretical and physical explanations.

Optimal Depth of Focus

Fundamental „Problem“

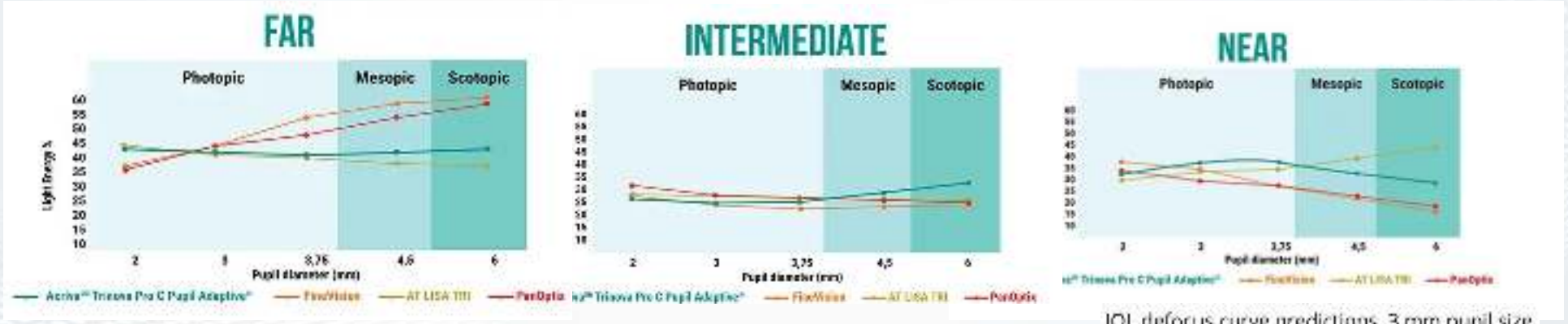
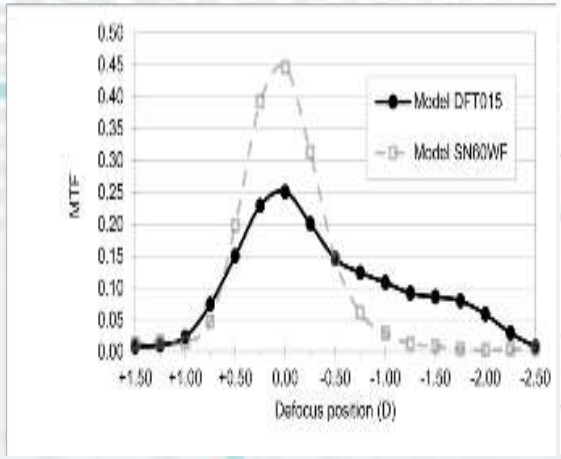


Figure 4: Modulation Transfer Function (MTF) Through-Focus Response of 20. IOLs in a Model Eye (White Light, 50 lp/mm, 3 mm Aperture)



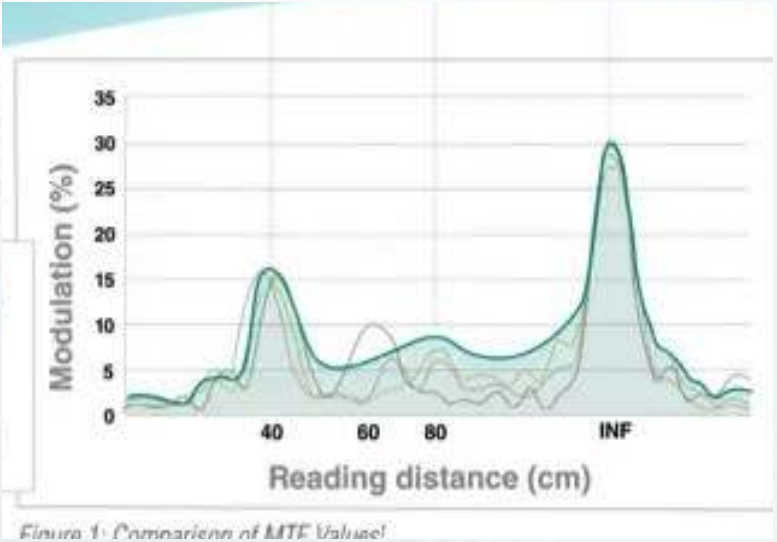
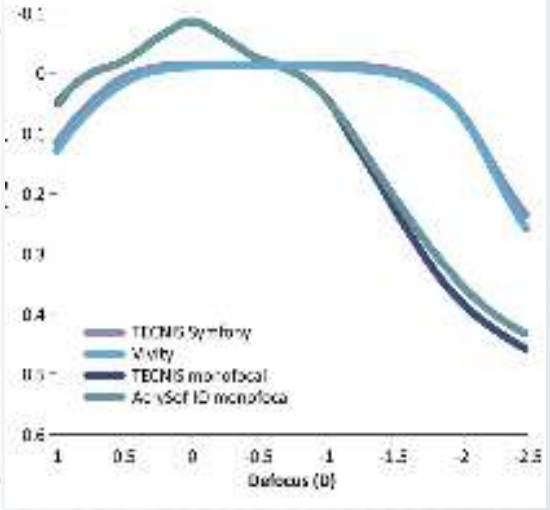


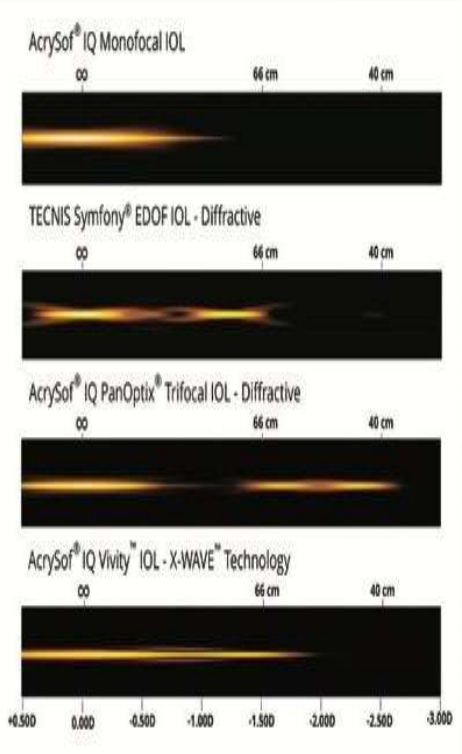
Figure 1: Comparison of MTF Values!

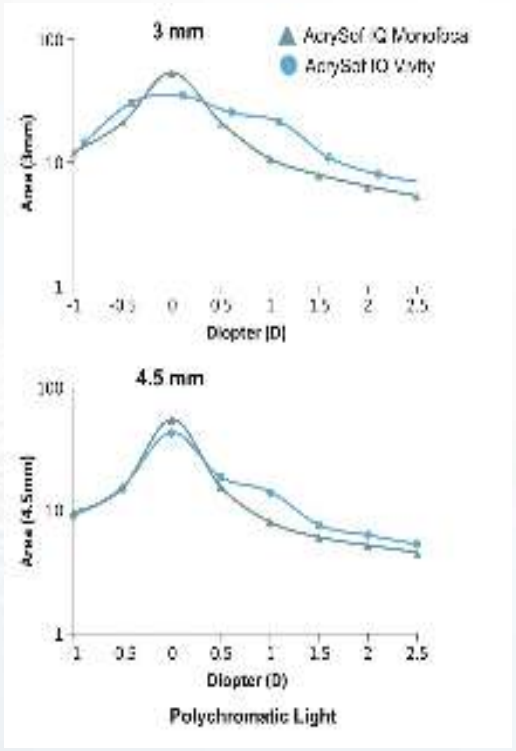
IOL defocus curve predictions, 3 mm pupil size.



Optimal Depth of Focus

Fundamental „Problem“





„simulation is for illustrative purposes o

Optimal Depth of Focus

Data

- Myriad of case series
- VA
  - For distance: All variants logMar 0,0 ± 0,05
  - For Intermediary distance
    - EDOF logMar 0,15 ± 0,1
    - Trifo logMar 0,3 ± 0,1
  - For Near
    - EDOF logMar 0,35±0,2
    - Trifo logMar 0,2 ± 0,1
- Contrast sensitivity
  - Few data
  - Driving requirements – no data found
- Photic phenomena
  - Trifo >(>) EDOF
- Patient satisfaction
  - Very satisfied/satisfied: 90 ± 5%
  - „would do it again“ 90 ± 5%
  - Corresponding roughly with „spectacle independance“ for different distances

„optimal/ideal patient selection“

and now…? How do I proceed

- First distinction: Cataract surgery or refractive correction (RLA)
  - „I want to see again as well as I used to“
  - „I see perfectly well but want to get rid of glasses“
    - „If so, then forever“ vs. „at least for everyday situation“
- Second distinction: Optimal Vision vs. optimal spectacle freedom
  - „Optimal vision must have – some spectacle independance nice to have“
  - „Spectacle freedom must have - if vision is good enough for everyday it‘s ok“
- Wait for the patient‘s spontaneous declaration of expectations
  - Make compromise nature unmistakably clear
- Do not raise (wring) expectations/ do not ask senseless questions:
  - „Would you like a lens with which you‘ll need no more glasses“....

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„optimal/ideal patient selection“

and now…? How do I proceed

Priority optimal Vision – Spectacle use (of course) minimized, but secondary

- Aberration correcting aspheric IOL
  - Individually optimized
    - (eg Hoya -0,11 – Alcon – 0,17 – Tecnis – 0,27 µ)
  - If needed. toric (Astigmatism > 1(,25); incision-meridian selected – AK???
- Target refraction
  - Prior hyperope: Nächst +0.25
  - Prior emmetrope: Nächst – 0,25
  - Prior (higher) myope:
    - Contact lens wearers: as emmetrope
    - Spectacle wearers: Individually – consider around -2,(2)5
- Special situation: „A little compromise for a bit less spectacles“
  - (Mini-) Monovision
  - Consider prior lifelong situation – „vision habits“

„optimal/ideal patient selection“

and now…? How do I proceed

Priority Spectacle independence

- Again: Clear communication of the compromise nature of every option
- Simulate, what can be simulated
  - Contact lens simulation of monovision
  - I recommend always as first option
- Demonstrate, what – and as best possible – can be demonstrated
  - Images - Example
- Communicate options for „emergency breaks“
  - Refractive optimization options if needed
  - Exchange if needed

Dysphotopsia – demonstration-plates

„optimal/ideal patient selection“

and now…? How do I proceed

Priority Spectacle independence

If monovision is declined

- Trifocal-IOL
- Demonstration
  - Photo-plates

- 4 Cardinal questions: Is for me best possible spectacle independence worth
  - A certain – limited – loss of contrast /(„Super-vision“ at daytime
  - Some more loss of contrast at dawn and nighttime
  - Glare and halos – demonstration with plates
    - Driving (esp at nighttime)!
  - Evtl necessity of refractive fine correction when emmetropia target is not ideally achieved

If answers are “not so very important – essential is no glasses necessary
The risk of wrong decision is minimal

„optimal/ideal patient selection“

and now...? How do I proceed

Some additional thoughts...

- „Never give a low Myope a multifocal IOL“
- With high cornealen aberrations or irregularities: cave multifokal solutions...
  - Consider IC8
- With narrow pupils cave multifokal solutions
  - Benefit from pinhole effect – copnsider aditional mini-monovision
- With multifocal options benefit from binocular summation
  - „Mix and match“????
- Avoid „as we all know“ prejudices
  - Extent of tolerable monovision
  - „Trying beats supposing“

„optimal/ideal patient selection“

and now…? How do I proceed

Priority Spectacle independence

If monovision ***and*** Trifo-disadvantages are not an option

- EDOF-IOL
  - Best remaining compromise:
  - Less DOC
  - Less loss of image quality

  Less spectacle dependence in daily life, but not spectacle freedom (Reading!)

- Which model?

  ?????
  - Study data not helpful: case series all ± equally „good to very good“
  - Consider optical characteristics
    - eg Eyhance a bit distance optimized, Vivity a bit intermediary/(near) optimized
    - Additional optical optimizations (SA-, CA-correcting, blue filter...,)
    - Diffractive Designs ? ??

„optimal/ideal patient selection“

and now…? How do I proceed

Special option: Pinhole – IC 8

- Advantage: EDOF without loss of image quality
- Disadvantage:
  - Dark adaptation impaired;
  - Funduscopy impaired (IR-transparency)
  - Limited DOF
  - Therefore recommended only monocularly
- So – when to consider?
  - Wish for EDOF, but only monocular surgery
  - With irregular stigmatism
  - Consider combination with Mini-Monovision
    - Make best use of DOF to both sides of the optimal focus!

Future Options

Simulation is unbeatable

- No verbal description can compete with self-perception
  - Especially, if the describer has never seen it ....
- SimVis Gekko Simulator
  - 2eyesvision.com

- 1stQ Simulator RALV –
  „Real Artificial Lens Vision“
  - Look through the real IOL

Some concluding thoughts from own experience

- Better listen „receptively“ to what patients want/miss, than „proactively“ present all possibilities
- Not „this is what you should do!“... but „what is important to you?“
- *Own* preferences are not necessarily relevant for *the patients* ...
- Take lifelong „vision habits“ into consideration
  - Hyperopes
  - Emmetropes
  - Low Myopes
  - High Myopes – lifelong Cl vs. glasses
  - Anisometropia
  - Importance of maximally sharp vision vs. minimal glasses
  - Distance priorities: „Near-animal“ vs. „Distance animal“

Vielen Dank