A JOURNEY THROUGH MULTIFOCAL IOLS AND MY PERSONAL EXPERIENCE WITH RAYNER TRIFOCAL IOLS

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Greetings from South Africa

Financial disclosures

- Provision [Lentis IOL]
- Epic Vision [Hanita Bunnylens]
- Epic Vision [Seelens MIOL]
- Epic vision [InFo MIOL]
- Eye Pharma [Physiol Fine Vision]
- Eye Pharma [iDiff MIOL]
- SOS [Rayner Trifocal]
- Ophtec [Precizon MIOL]

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Two definitions

- **Pres**byopia **cor**recting [**PresCor**] IOL's are designed to correct presbyopia utilizing **any effective** **optical** principle.

- **MIOL's [Multifocal IOL's]** are designed to correct presbyopia by creating **multiple focal points.**

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I have used the following Presbyopia Correcting IOL's

- **Accommodating**
  - Tetraflex by Lenstec
  - Crystalens
- **Bifocal**
  - 3M, AMO Array; AMO Rezoom; Alcon ReStor, Lentis Mplus, Hanita Bunnylens, Hanita Seelens, iDiff [Eye Pharma]
- **Trifocal.**
  - Physiol Fine Vision, Zeiss AT Lisa Tri, Alcon Panoptix, Rayner RayOne Trifocal
- **EDOF**
  - Tecnis Symfony, [Zeiss AT Lara]
- **Hybrid** [refractive, diffractive, EDOF]
  - Info [EDEN] from SAV
- **CTF** [Continuous Transition Focus] technology.
  - Precizon NVA IOL.

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PresCor IOL's used and evaluated.

Study	Retro- or prospect	IOL	Mechanism of action	Bifocal or Trifocal	Total eyes	Male eyes	Female eyes	Ave Age
2009	Retro	Alcon ReSTOR	Refr, Diffr, apodized	Bifocal	114	40	74	62
2011	Pro	Lentis Mplus	Refractive	Bifocal	113	52	61	63
2013	Pro	Physiol Fine Vision Trifocal	Diffractive apodized	Trifocal	50	18	32	61
2015	Pro	Hanita Bunnylens MF	Diffractive apodized	Bifocal	28	12	16	60
2015	Pro	Zeiss AT Lisa Tri 839MP	Diffractive	Trifocal	52	20	32	57
2015	Pro	Tecnis Symfony extended focus	EDOF. Diffractive	Extended focus	30	15	15	60
2016	Pro	InFo-Instant Focus	EDOF; Diffract. Refractive.	Focal Field or luminous tube	44	10	34	58
2017	Pro	Hanita Seelens	Diffractive apodized	Bifocal	35	21	14	58
2017	Pro	Alcon Panoptix	Diffractive	Trifocal	26	6	20	61
2018	Pro	Rayner Trifocal	Diffractive	Trifocal	32	6	26	64
2019	Pro	iDiff Plus	Midified Refractive-Diffractive	Bifocal	4	2	2	54
2019	Pro	Precizon NVA	Refractive	Bifocal - Continious Transitional Focus	8	2	6	74
				TOTALS	**536**	**204**	**332**	

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FACTORS DETERMINING MIOL RESULTS

- **PATIENT SELECTION**
- Patient communication
- Perfecting the eye around the MIOL.
- Optic principles behind MIOL's
- The MIOL itself.

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Factors determining MIOL results

Patient selection

Extremely important.

- Personality
- Gender
- Activities
- Eyes

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Patient selection.

Personality

- **NO**
  - Perfectionists
  - Aggressive and demanding personality
- **YES**
  - Easy going people
  - People losing or not using their spectacles

Gender

- Women better candidates than men
- Aggressive men are poor candidates

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Patient selection.

Activities

- **NO**
  - People with high visual requirements
  - People working at night
  - In dark places
  - Astronomers, bird watchers or photographers.
- **YES**
  - Sport people,
  - Party people.
  - Farmers.
  - Outdoor workers

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Patient selection.
This also means eye selection

- No pathology except cataracts.
- Only **correctable** astigmatism.
- Any patient who is totally dependent on spectacles
  - Best patient is hyperopic because pre-op they always depend on glasses
  - Myopic eyes up to -3.5 D are not good because:
    - They read without glasses
    - They may lose some Best corrected BCNVA
- The worse they start the happier they end. Usually.

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Patient selection – Eyes:

Summary of eye selection

- ▫ Normal eyes except for cataract
- ▫ Healthy external eyes

- ▫ **Patient who ALWAYS has to wear spectacles**
  - ▪ Hyperopia
  - ▪ Astigmatism
  - ▪ High Myopia

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Patient selection. Summary

- **Best Patient**: Relaxed, friendly, hyperopic lady who do not do many visually challenging tasks and is **totally dependent on her spectacles.**

- **Worst patient**: Aggressive, myopic, alpha male with high visual requirements and a short temper, who spends many hours reading without his glasses.

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FACTORS DETERMINING MIOL RESULTS

- Patient selection
- **PATIENT COMMUNICATION**
  - **DOCTOR'S RESPONSIBILITY**
  - **PATIENT'S RESPONSE**
- Perfecting the eye around the MIOL.
- Optic principles behind MIOL's
- The MIOL itself.

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Patient communication.

Doctor's responsibility: **Remember:**

- Listen to the patient [to understand, not to answer]
- Smile
  - Friendly
  - Make the patient your friend.
  - Get the patient to smile.
- Never be arrogant.
  - Patients do not sue a doctor if he makes a mistake.
  - **They sue him if they do not like him.**
  - Arrogance annoys patients tremendously

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Patient communication

Doctor' responsibility:

- Chair time. [Dr or assistant]
- Set realistic expectations.
    - Explain adaptation period [neuro adaptation]
    - Explain the different focal points
- Explain side effects.
- Show pictures, videos, animations.
- Get informed signed consent

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Patient communication

Doctor's responsibility

▫ **Create trust**

▫ A patient does not care what you know until he knows that you care

▫ See a patient for a second time pre-op [free of charge] to explain everything again.

■ It reduces fear

■ It creates trust.

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Patient communication

Patient response:

- They often do not listen
  - They are often afraid and fearful
  - Patients remember 10% of what the doctor says.
  - Information overload = more to forget

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Patient communication

Patient response:

- They often do not <u>understand:</u>
  - They have limited knowledge
  - New information can be confusing.
  - Visual material: Information video. Models, Pictures
  - Most patients just want to know that you know
  - Exceptions: Some patients truly want to understand. Engineers etc.

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Patient communication

Patient response:

▫ Often do not <u>remember</u> because:

- They had limited knowledge anyway
- They only heard **10%**
- They did not fully understand

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Patient communication: Expectations

- Most people expect more than what we can deliver
- They want eyes like a 20 year old person
- They do not know how they will react to the side effects of the MIOL
- Under-promise and over-deliver

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FACTORS DETERMINING MIOL RESULTS

▫ Patient selection

▫ Patient communication

▫ **PERFECTING THE EYE AROUND THE MIOL**

- ▪ **EXTREMELY IMPORTANT!**

▫ Optic principles behind MIOL'S

▫ The MIOL itself

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Perfecting the eye around the MIOL

Pre-operatively:

- ▫ Healthy eyes except for cataract
  - ▪ No ocular pathology (corneal, iris, vitreous, macular, retinal, optic nerve)
  - ▪ No significant external eye diseases.
- ▫ Do a perfect biometry
  - ▪ Aim for spherical equivalent -0.50 to +0.50
- ▫ Measure astigmatism accurately
- ▫ Plan treatment such as:
  - ▪ Toric MIOL if astigmatism ≥1.25D
  - ▪ Rx astigmatism of 0.75 to 1.0D

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Perfecting the eye around the MIOL

Intra-operatively

- Eliminate astigmatism
  - Compensate for SIA [surgically induced astigmatism]
  - Consider OCCI, LRI's or arcuate keratotomies
  - Toric MIOL
- Make a perfect CCC [I do 4.8mm]
  - We use the Callisto [Zeiss]
  - Use Zepto ring
  - Or FLACS [we use the Z8 Ziemer FS Laser]
- Avoid decentration or tilt of MIOL
  - Decentration: 0 to 400μ acceptable
  - Tilt: Not more than 3°
- Post capsule must be intact

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Perfecting the eye around the MIOL

<u>Post-operatively</u>

- YAG early, provided the patient wants to retain the MIOL

- Correct residual refractive errors with Excimer Laser refractive surgery

- If MIOL replacement is required, do it as soon as possible
  - Conundrum: how long does neuro adaptation take?
  - When is it too late?

FACTORS DETERMINING MIOL RESULTS

- ▫ Patient selection
- ▫ Patient communication
- ▫ Perfecting the eye around the MIOL.
- ▫ OPTICAL PRINCIPLES BEHIND MIOL'S
- ▫ The MIOL itself.

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Optical principles of Presbyopia correcting IOL's.

Remember the two definitions

- **Pres**byopia **cor**recting [**PresCor**] IOL's correct presbyopia using **any effective optical** beam paths.

- **MIOL's [Multifocal IOL's]** correct presbyopia by creating **multiple focal points**

MIOL's are one type of PresCor IOL's

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Optical Principles behind creation of Presbyopia correcting IOL's

Combinations of different optical principles are used to create PresCor IOL's.

- Refractive IOL basis
  - It forms the basis of every IOL
  - Refractive segments or spherical variations can create many effects
  - Periphery of RayOne, Panoptix is solely refractive
- Diffractive rings of different shapes and sizes
  - Central 4.5 mm of RayOne and Panoptix
  - Full optic of Physiol Fine Vision as well as Zeiss AT Lisa Tri

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Different types of MIOL's produced by combining Optical principals

- Bifocal. 2 focal points.

- Trifocal. 3 focal points.

- EDOF IOL's

- Hybrid IOL's.

- CTF [Continuous Transition focus] IOL's

- Pinhole [IC8 Acufocus]

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Diffraction.

- It is the breaking up and bending of an incoming wave around the edges of an obstruction or a slit.

- The amount of bending depends on the wavelength of light compared to the size of the obstruction or slit.

- Every point on the deviated wave front becomes a secondary source of waves

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Diffraction [continued]

- Reconstruction of the wave causes wave crests and troughs which can either add up or eliminate each other. [interference]
- This forms an alternating diffractive pattern of
  - dark and light or
  - different coloured bands.
- The dominant diffraction crests represent the lens focus.
- Diffraction is 3 dimensional

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Diffractive pattern of bifocal diffractive IOL
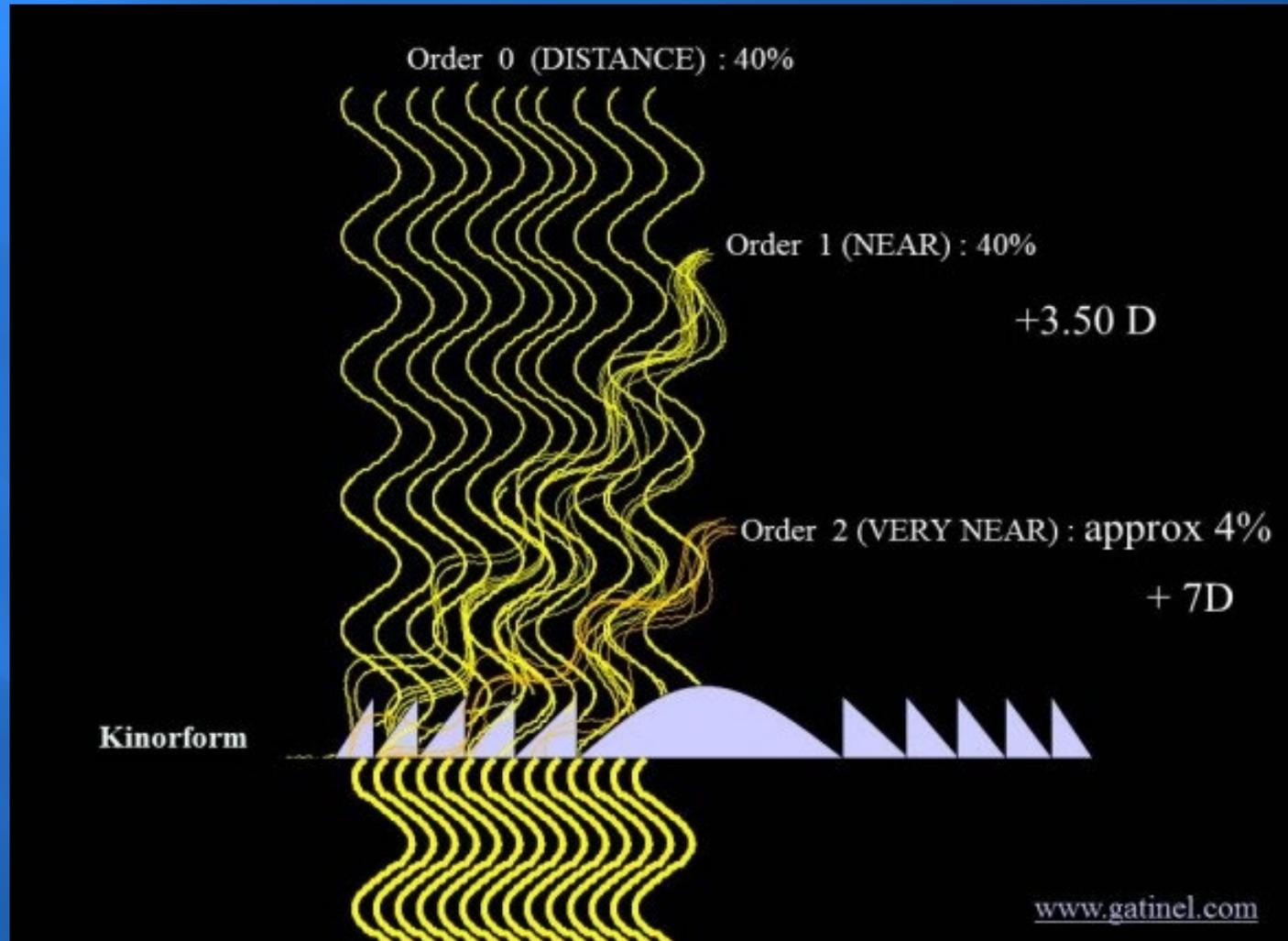
Diffractive Trifocal IOL design
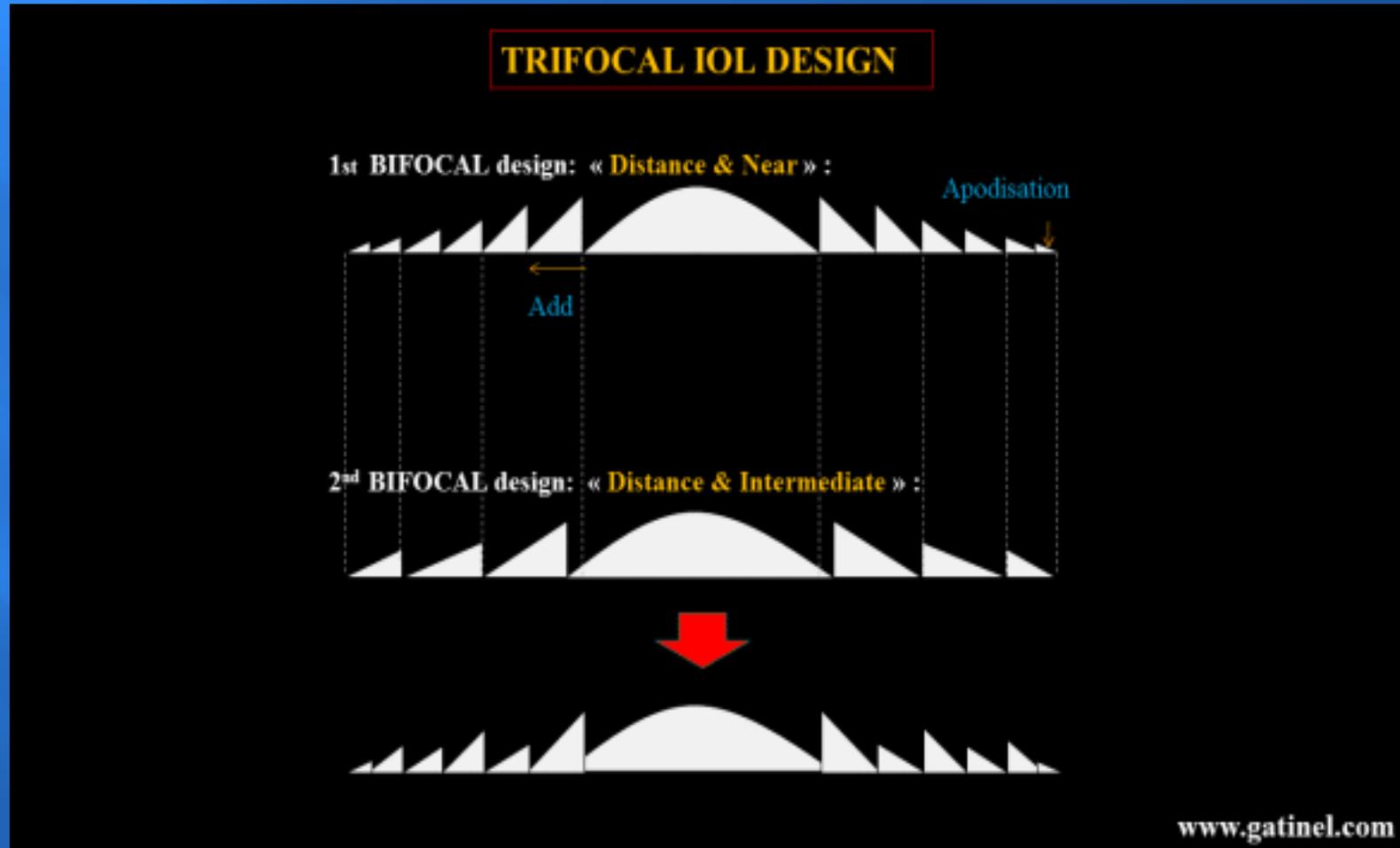
RayOne Trifocal diffractive beam path and focal points

- Beam Path of diffractive Trifocal IOL
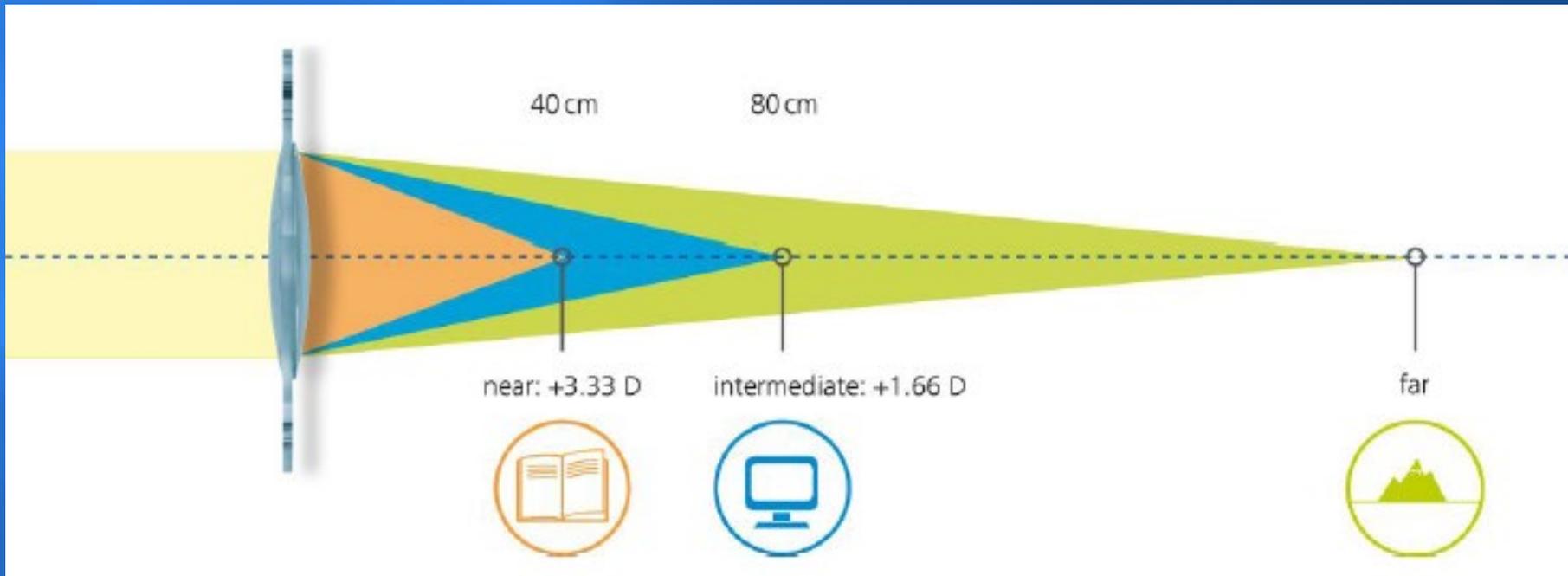
More optical principles: Contrast sensitivity: [MTF]

- ▫ MTF [modulation transfer function] is the parameter used to measure contrast sensitivity.
- ▫ It measures the eye's ability to distinguish between similar but separate images
- ▫ Images have a grating [spatial frequency] of more or less lines per mm or cycles per degree [cpd] –
- ▫ We measured it with the **FACT** chart

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Optical principles: Contrast sensitivity

Factors reducing contrast sensitivity:

- Division of light reduce light availability for any given distance

- Out of focus light cause some blur. This will reduce contrast sensitivity.

- Stray light:[scatter]
  - Causes extensive light distribution on the retina, with overall brightening in the visual field. {Glare}
  - Glare is quite disturbing to the patient

Very few patients complain about reduction in contrast sensitivity

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Optical Priciples: Side effects of MIOL's:

Based on the laws of physics, dysphotopsia are inevitable with MIOL's.

- Positive dysphotopsia
  - Halo's
  - Starburst
  - Glare. Too much scatter of light.
- Negative dysphotopsia
  - A perceived shadow in the temporal visual field. It is caused by the edge of the IOL and happens with monofocal IOL's as well.

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Summary of Optic principles behind PresCor IOL's.

- **Optics** are ALWAYS subject to the laws of physics
- Light is **divided** and redistributed.
  - **Redistributed** in different ways in diffractive, refractive or EDOF MIOL's
- Light is **reduced** with pinhole MIOL's
- **Side effects** are **inevitable:**
  - Dysphotopsia
  - Contrast loss
  - Reduced VA in poor light

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FACTORS DETERMINING MIOL RESULTS

- ▫ Patient selection
- ▫ Patient communication
- ▫ Perfecting the eye around the MIOL.
- ▫ Optic principles behind MIOL's
- ▫ **THE MIOL ITSELF.**

Comparing four different Trifocal IOL's

4 Diffractive Trifocals
- Physiol Finevision
- Zeiss AT Lisa Tri.
- Alcon Panoptix.
- RayOne Trifocal.

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Comparing trifocal diffractive Technologies

PHYSIOL FINE VISION
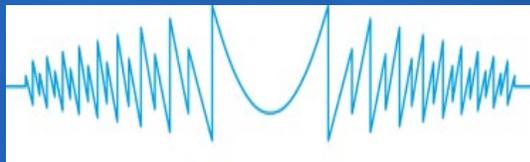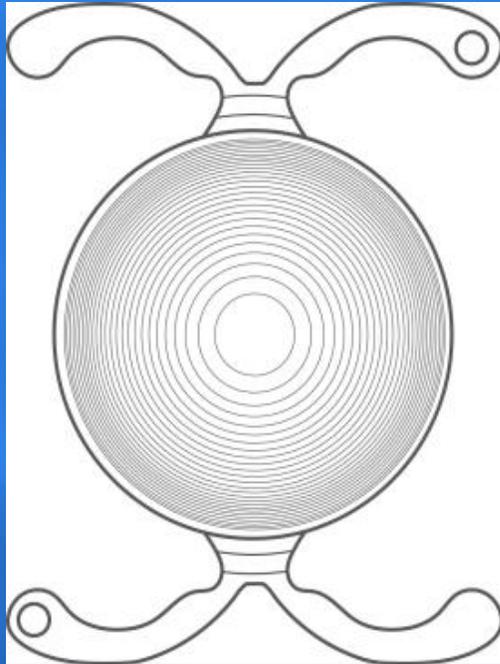
ZEISS AT LISA TRI
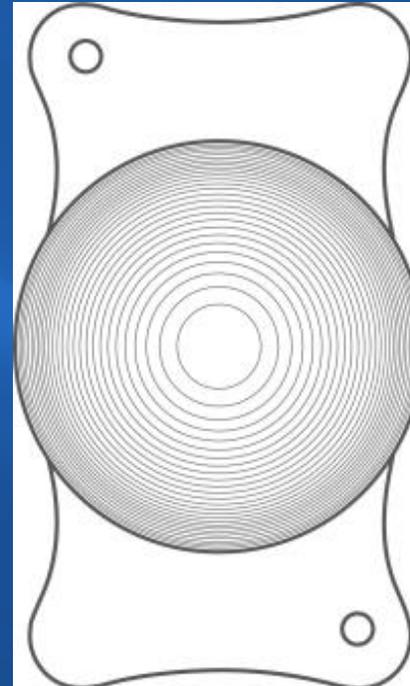
Comparing trifocal diffractive technologies

ALCON PANOPTIX
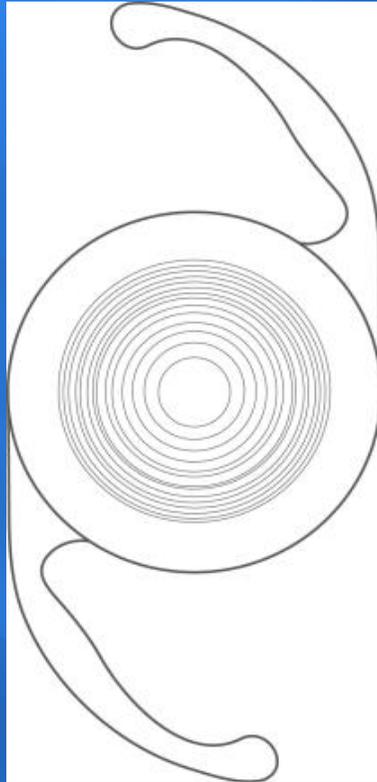
RAYONE TRIFOCAL
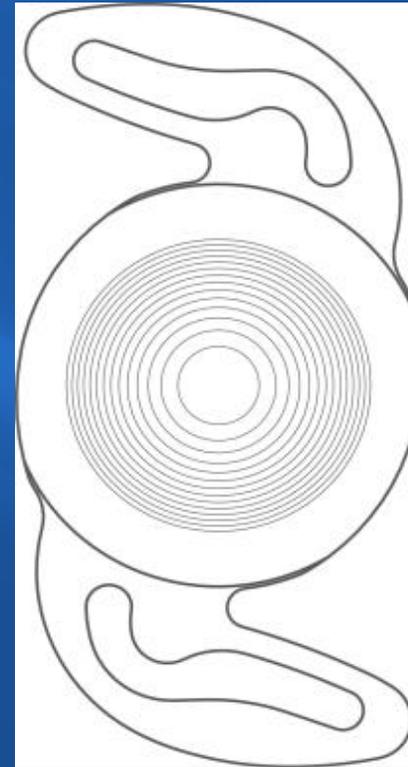
Some characteristics of these 4 trifocals

- **Physiol Fine vision Trifocal**
  - Only diffractive.
  - Rings extend to periphery.
  - Add +1.75D and +3.50D
  - Light Scatter 15%
- **Zeiss AT Lisa Tri**
  - Only diffractive.
  - Rings extend to periphery.
  - Add +1.66 and 3.3D
  - Light scatter 14%

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Some characteristics of these 4 trifocals

- **Alcon Panoptix**
  - Diffractive
  - Actually quadrifocal.
  - Rings only central 4.5mm
  - **Add +2.17 and 3.25D**
  - **Light scatter 12%**
- **RayOne Trifocal**
  - Diffractive.
  - Rings only central 4.5mm
  - **Add +1.75 and 3.50D**
  - **Light scatter 11%**

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Comparison of Light Distribution

Lens	Far	Intermediate	Near	Scattered "Lost" light	Total utilization
Physiol Fine Vision	41%	15%	29%	15%	85%
Zeiss AT Lisa Tri 839MP	50%	20%	30%	12.5%	87.5%
Alcon Panoptix	± 41%	± 22%	± 25%	12%	88%
RayOne Trifocal	52%	22%	26%	11%	89%

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UV Protection

- **Physiol Finevision**
  - UV & blue light Filtering
- **AT Lisa Tri**
  - Ultraviolet Light Filter
- **Panoptix**
  - UV filter: Yellow acrylate/methacrylate copolymer
- **RayOne Trifocal**
  - UV Protection: Benzophenone UV absorbing agent

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RayOne Trifocal Specifications

- Material: Single piece Rayacryl **hydrophilic** acrylic
- UV Protection: Benzophenone UV absorbing agent
- UV Light Transmission: UV 10% cut-off is 380 nm
- Overall Diameter: 12.50 mm
- Optic Diameter: 6.00 mm
- Optic Shape: Biconvex (positive powers)
- Optic Edge: Amon-Apple 360° enhanced square edge
- A-Constant: 118.6
- Less rings on the optic surface than many trifocal IOLs for reduced side effects and improved night vision.

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RayOne Trifocal IOL

Defocus curve of RayOne Trifocal
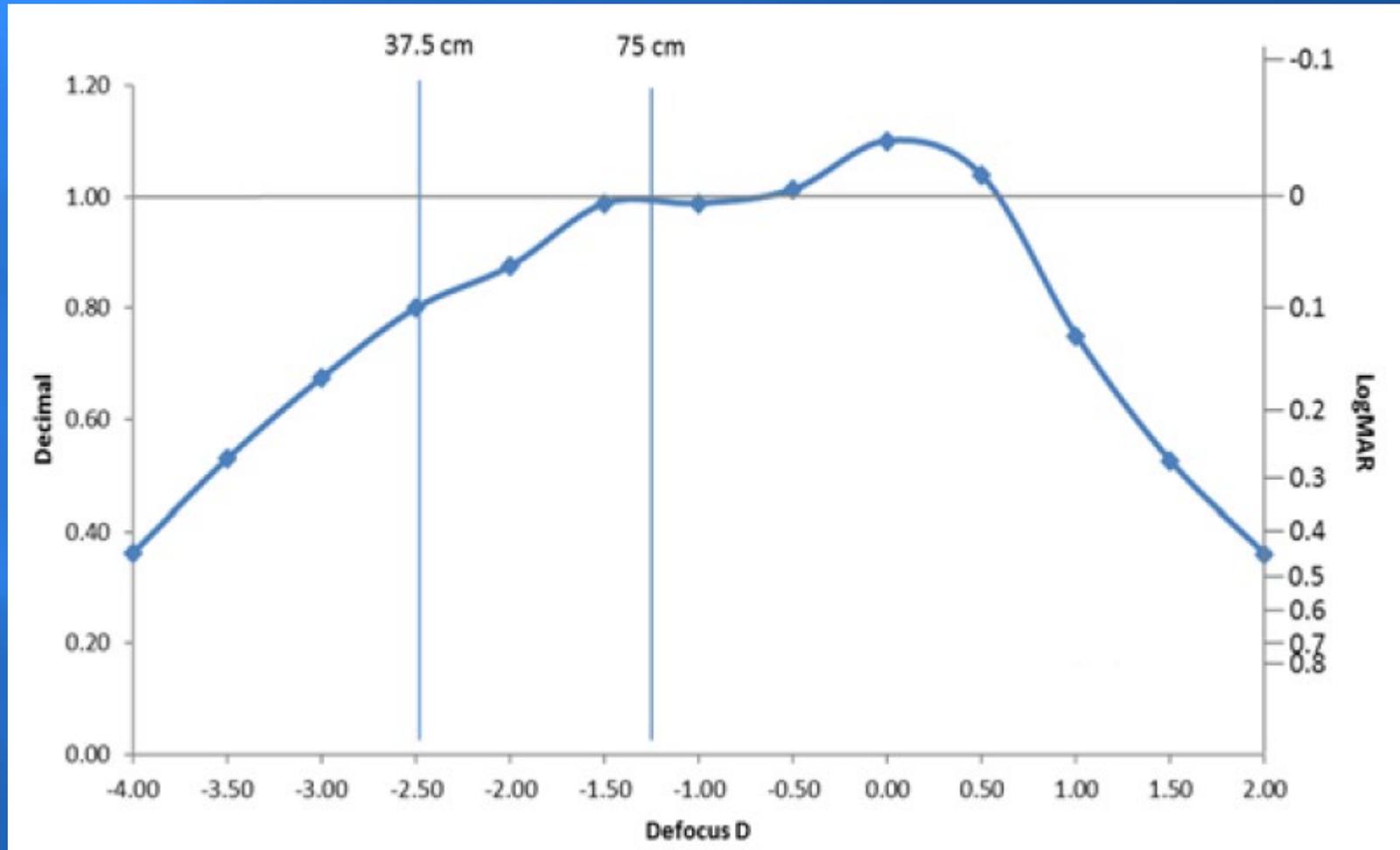
Defocus curve of Physiol Fine Vision.
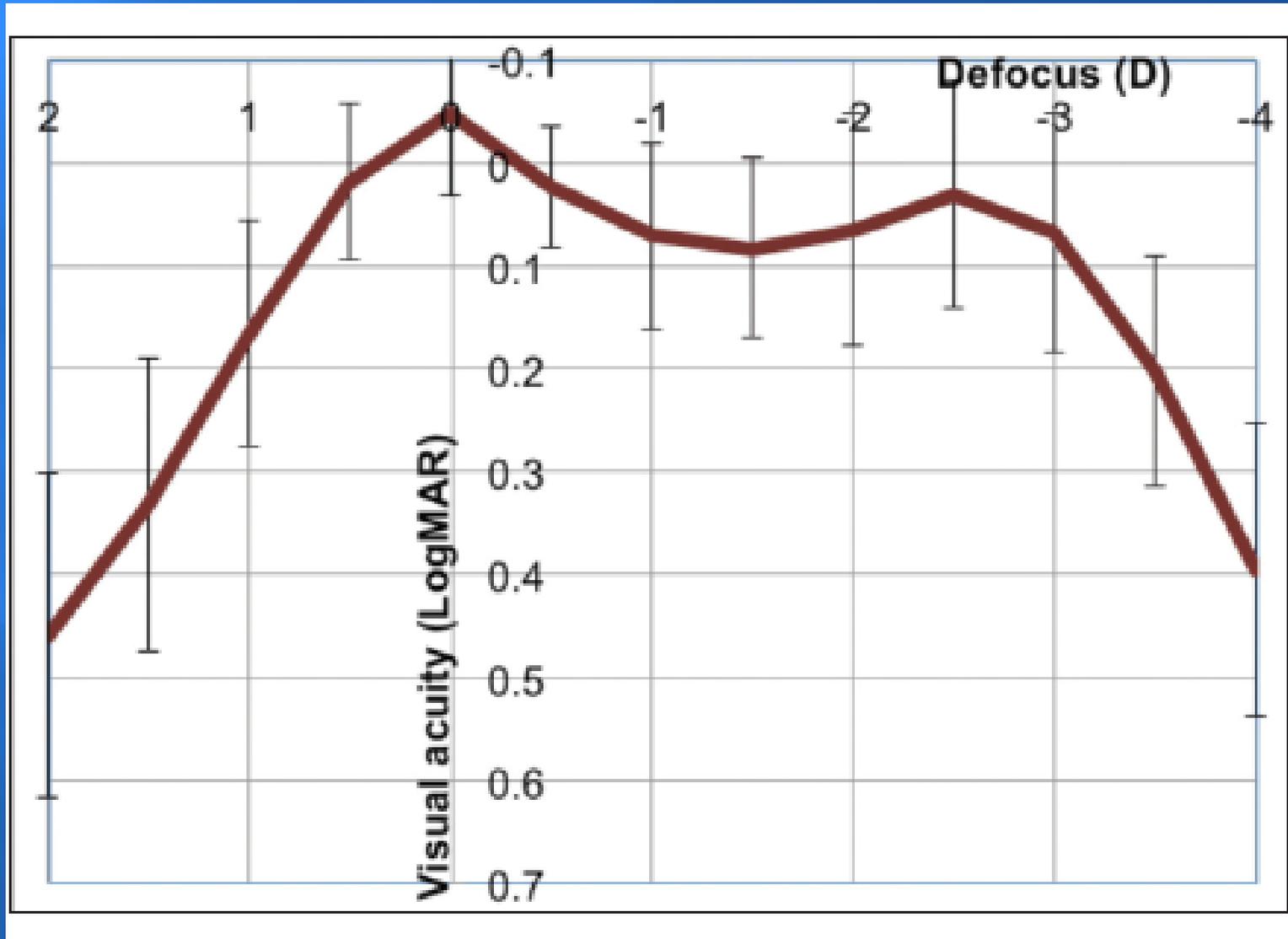
# Defocus Curve of Zeiss AT Lisa Tri 839MP
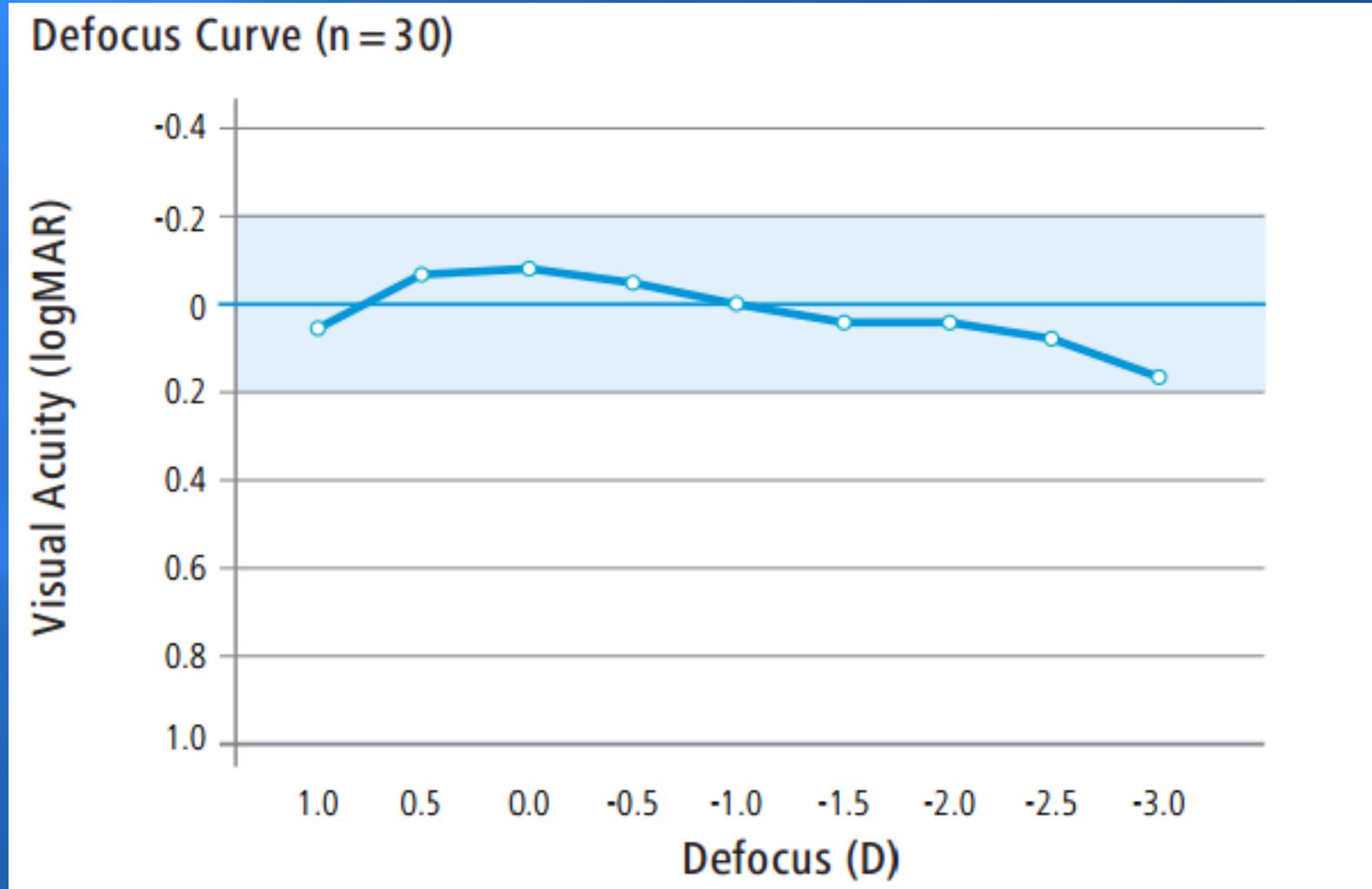
Defocus curve of Panoptix IOL
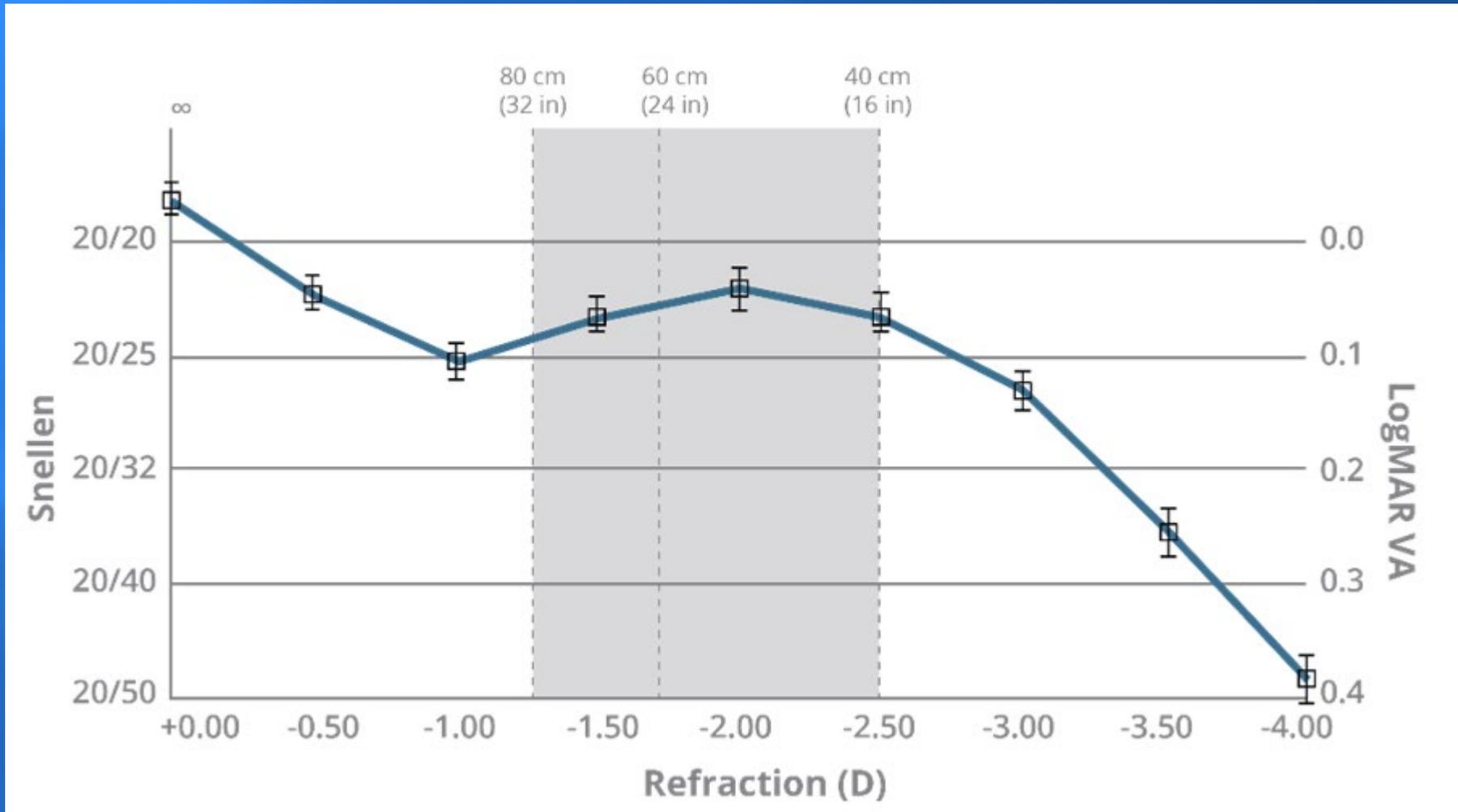
Our results:
Mean UVA's of the 4 MIOL's we used
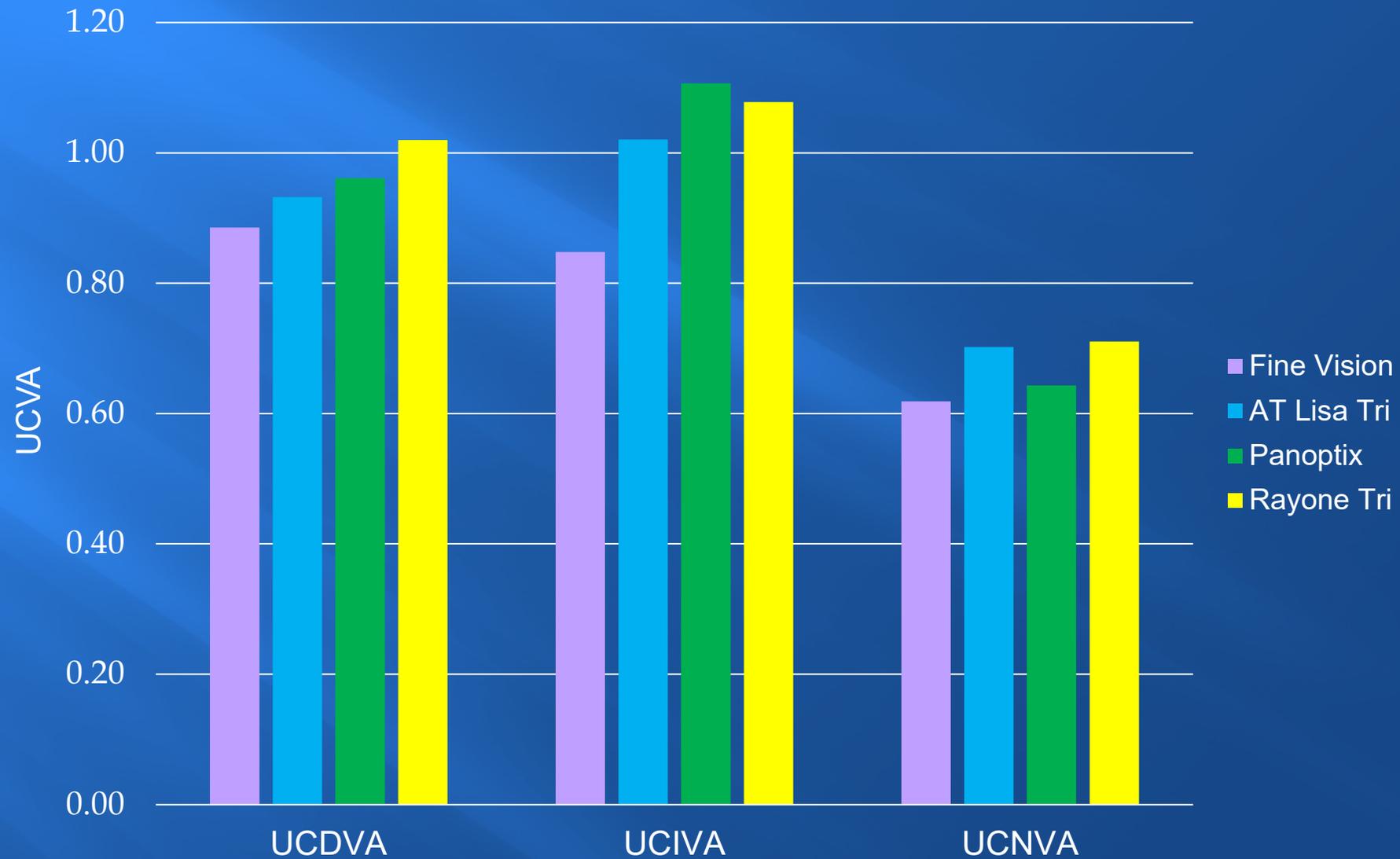
Results:
Comparing mean contrast sensitivity
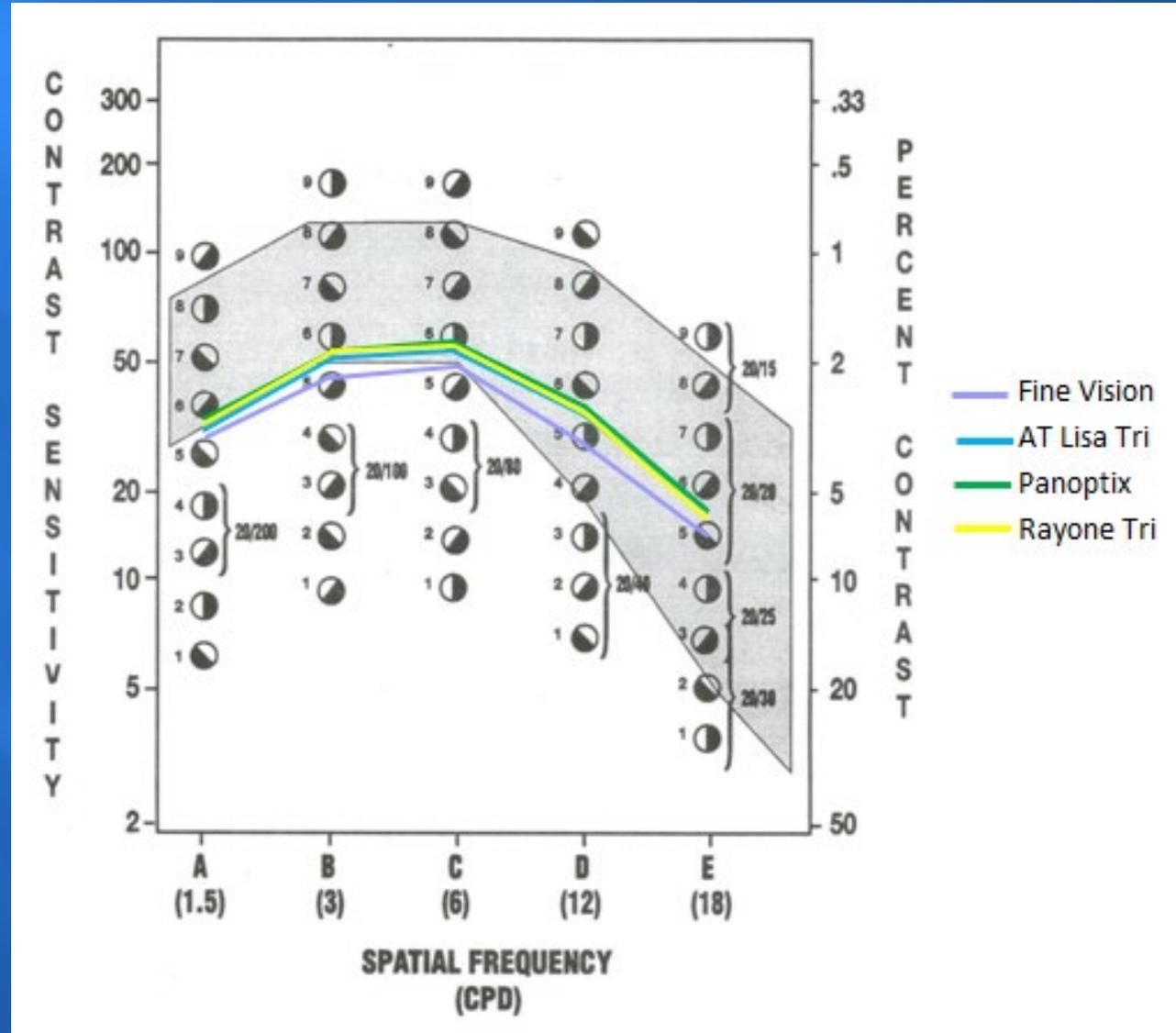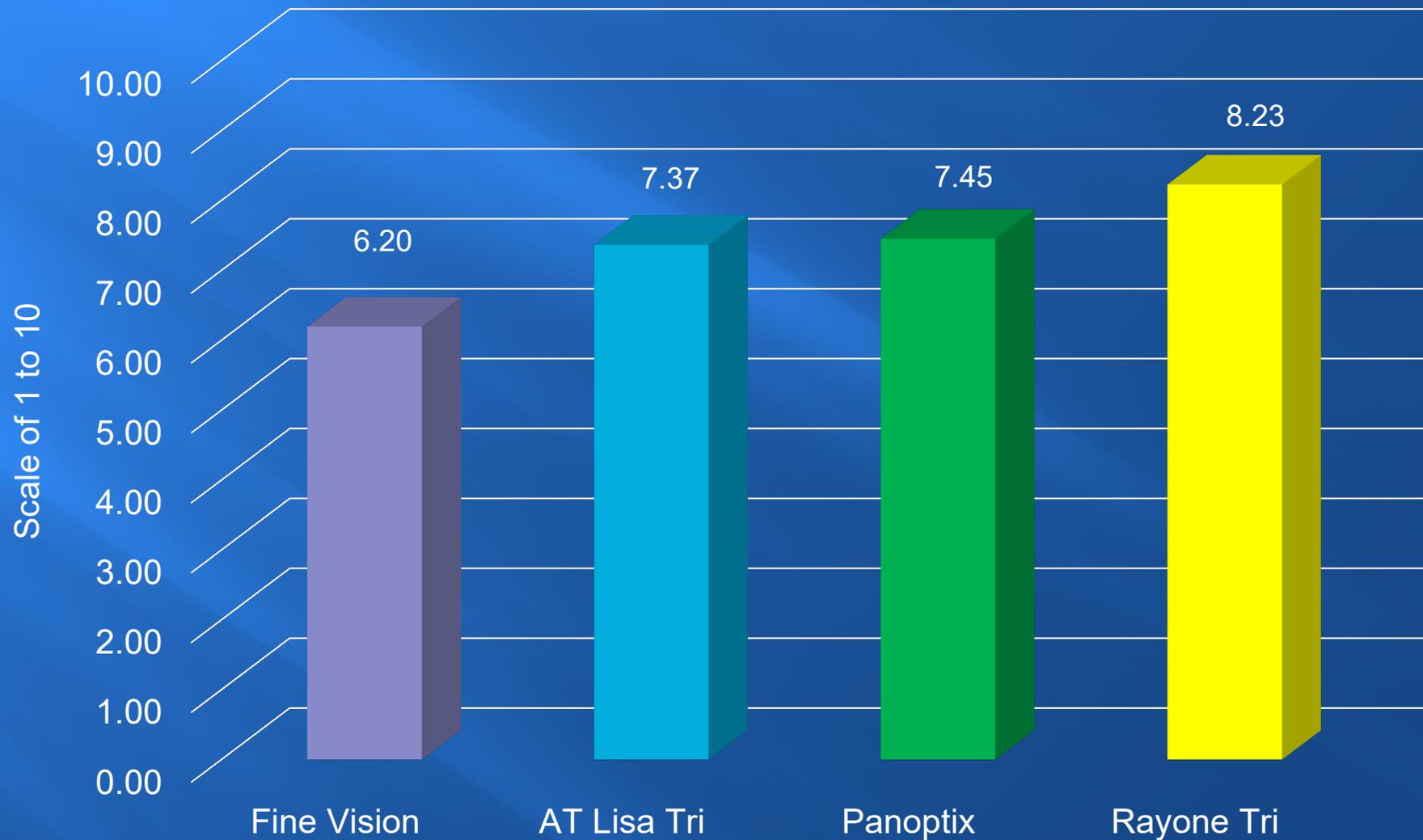
Results:
Happiness with IOL.
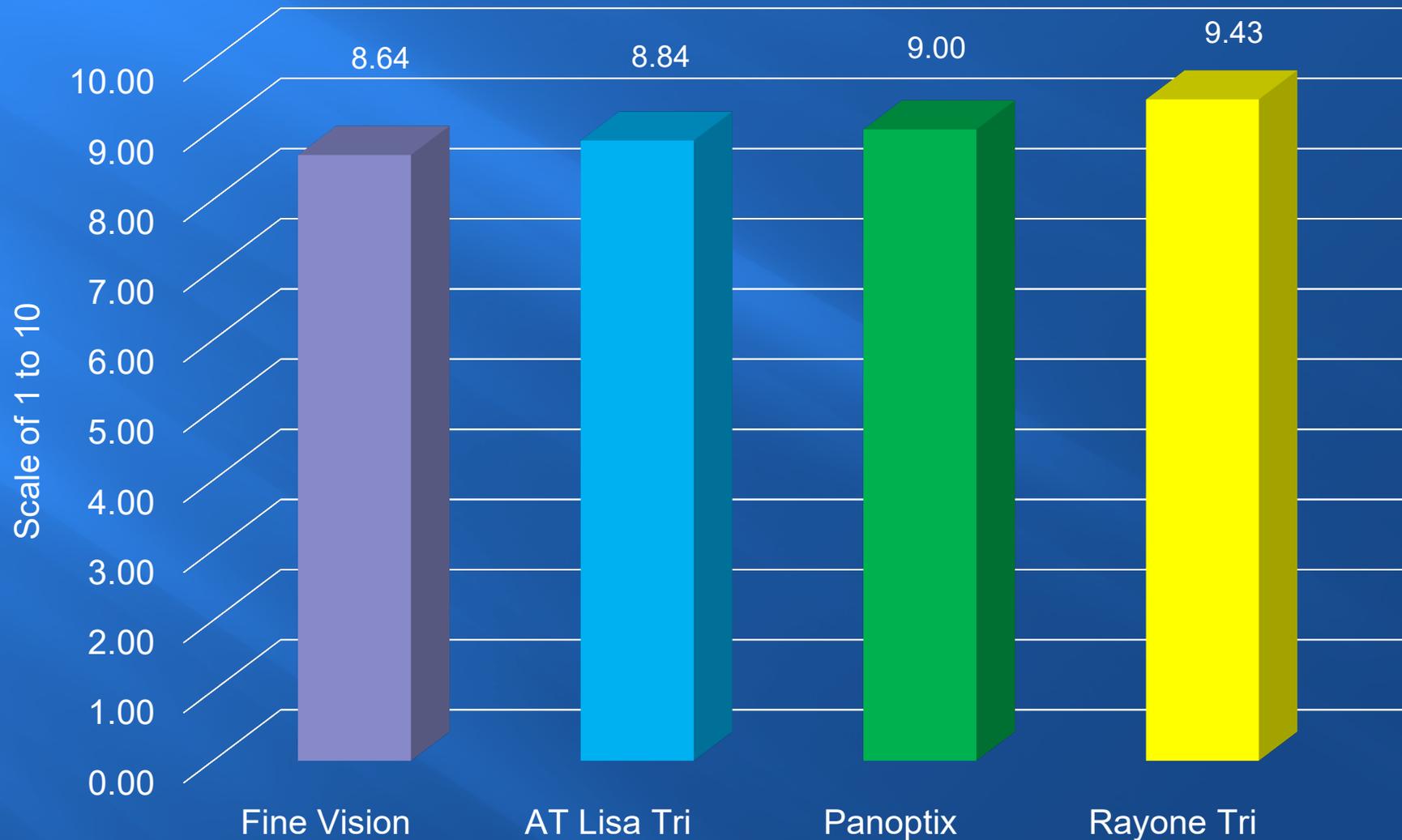
Will you do the operation again
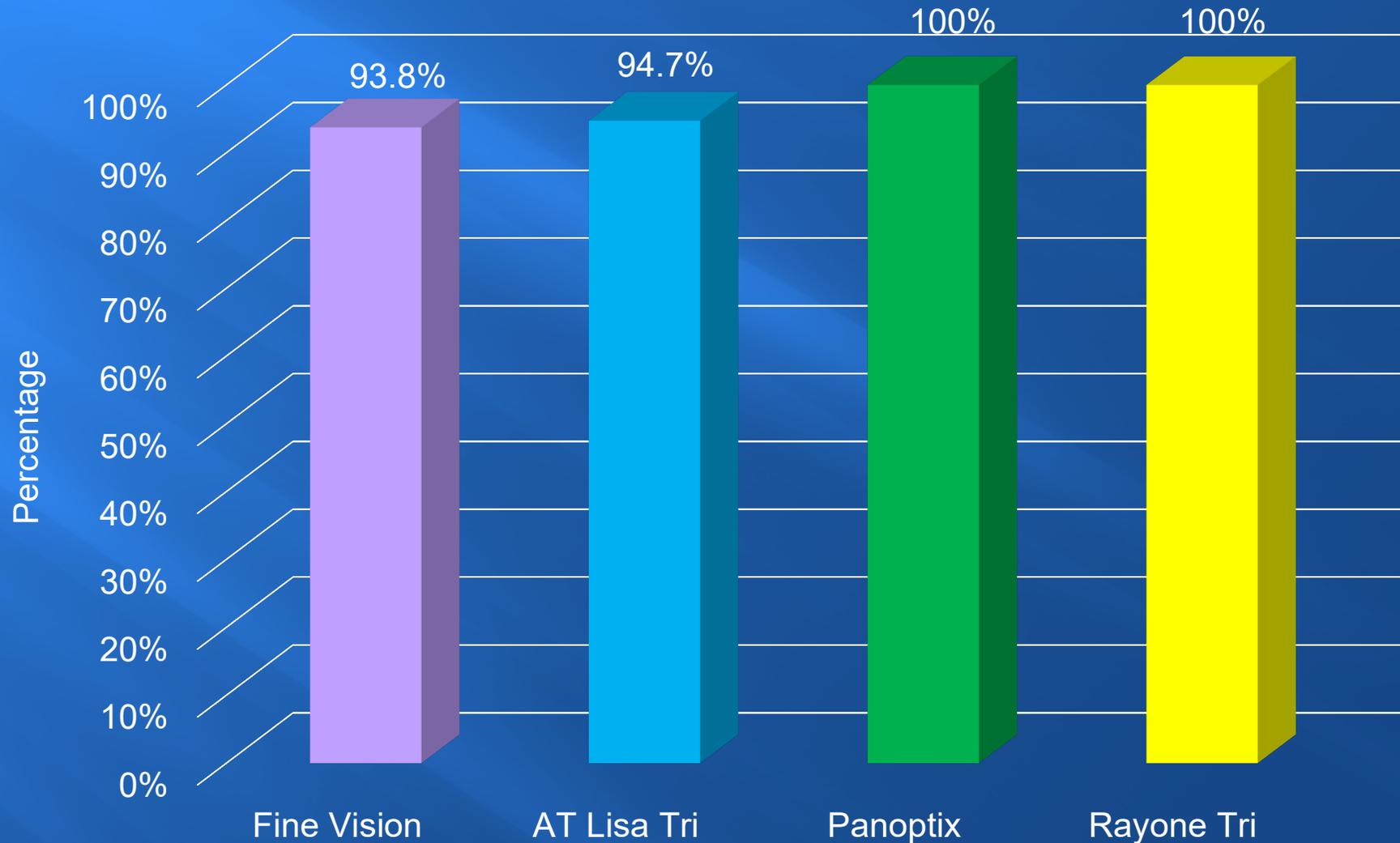
Advantages of the RayOne Trifocal

- Haptics: Closed loop with Anti-Vaulting Haptic (AVH) technology.
- Due to the haptic design it centres very well .
- No tilt was observed
- Colourless [I don't like yellow MIOL"s]
- Only 16 rings. Less diffractive rings create less scatter and less dysphotopsia.
- Patients reported less scatter than other Trifocal's. ["softer" MIOL]

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RayOne Trifocal: Myopic shift seen with autorefractors

- Post-op auto-refraction values are ALWAYS more negative than the actual refraction, by about 1.25D

- Patients have 1.0 UDVA but AR gives -1.25D refraction

- Possible reason: Rayner uses the -1 diffractive order for distance and the 0 order for intermediate vision

- The autorefractor picks up the intermediate focus

- We used the Topcon TRK-2P and Nidek Tonoref II auto-refractors.

- Advice to surgeons: certain autorefractor machines consistently show emmetropic patients to be around -1.5D or -1Dioptre

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Summary [positive results]

- All 4 trifocals yielded excellent results subjectively as well as objectively.
- In the graphs shown the RayOne Trifocal had:
  - The best UDVA
  - Best UNVA
  - Best Happiness with MIOL values
  - Best vision in poor light
- The RayOne also showed the shortest adaptation time. [0 to 14 days].
- **The series too small to come to final conclusions.**

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Summary. [side effects]

All 4 Trifocal MIOL's:

- ▣ Caused dysphotopsia
- ▣ Caused some reduced VA in poor light
- ▣ Caused slight reduction in contrast sensitivity
- ▣ Lost efficacy if astigmatism was ≥ 0.75D.
- ▣ Lost efficacy in the presence of PCO.

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Final comment

- Side effects were similar but;
    - RayOne Trifocal patients had least complaints of scatter of the 4 Trifocals.
    - RayOne Trifocal had the shortest adaptation period, 1 day to two weeks
- The RayOne Trifocal also compared favourably with hybrid and EDOF MIOL's not discussed in this talk.

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Thank you for your attention

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