LA APASIONANTE HISTORIA DE LAS LENTES INTRAOCULARES

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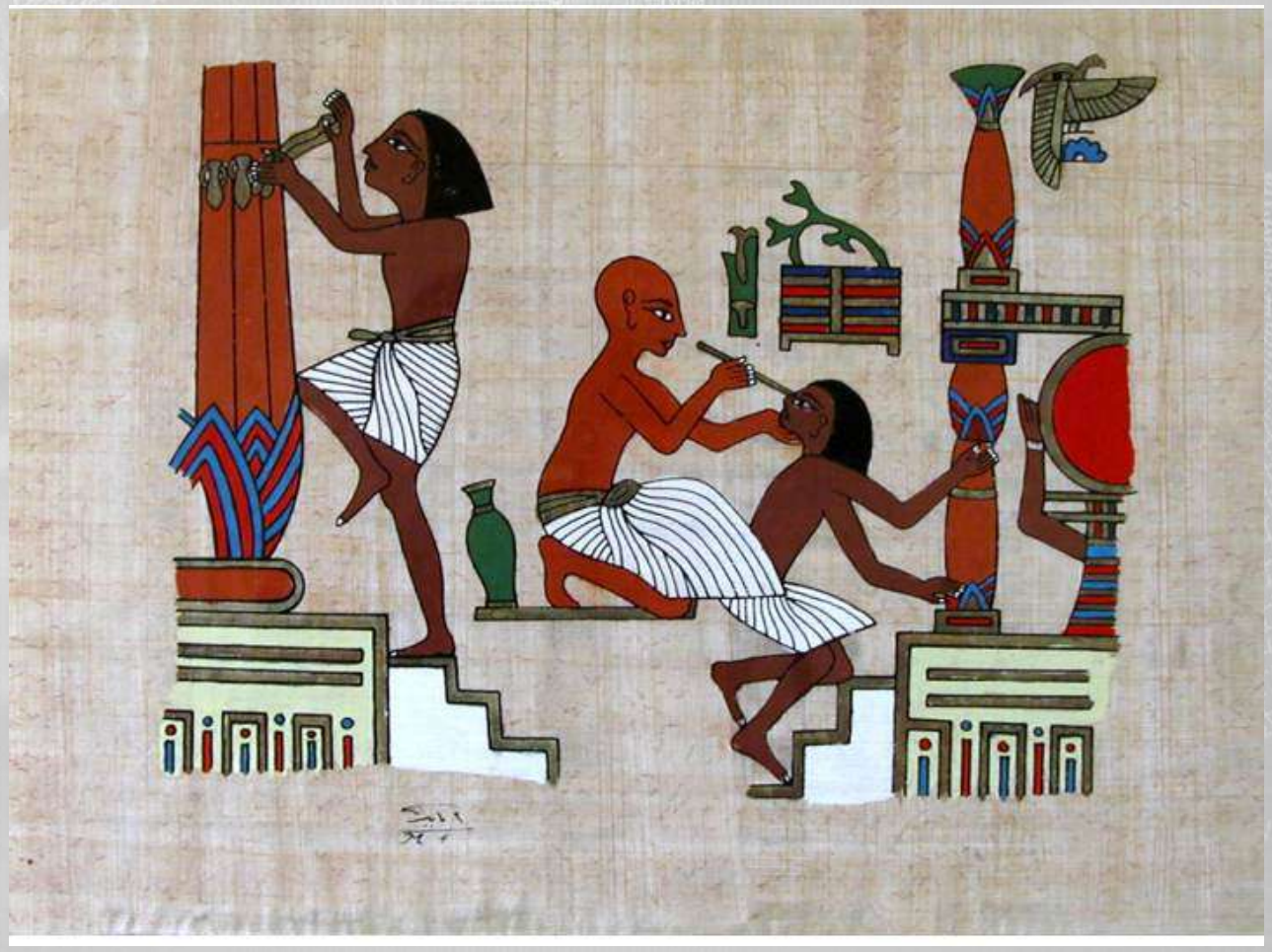
De la Comunidad Valenciana

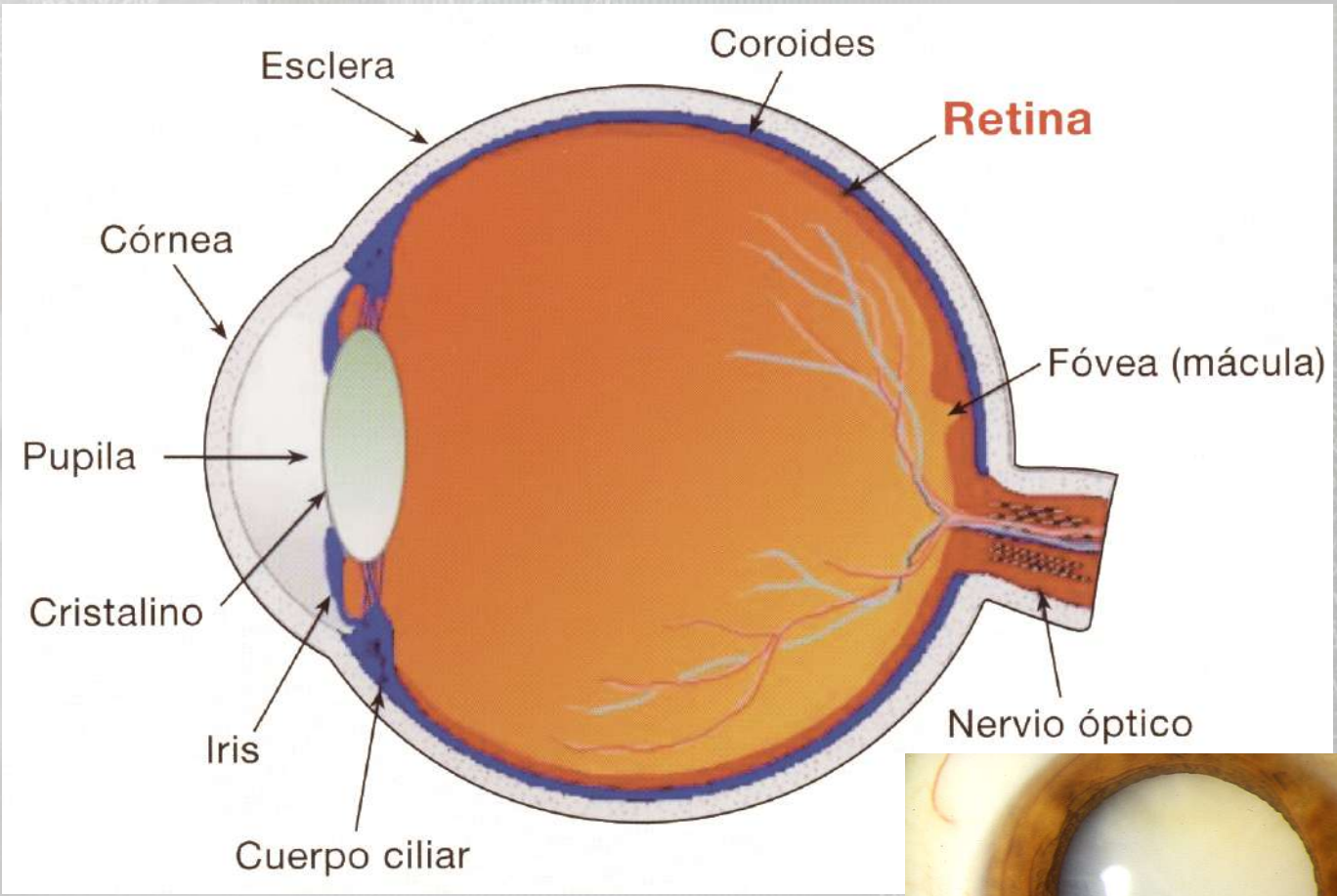
EUROPEAN ACADEMY OF OPHTHALMOLOGY

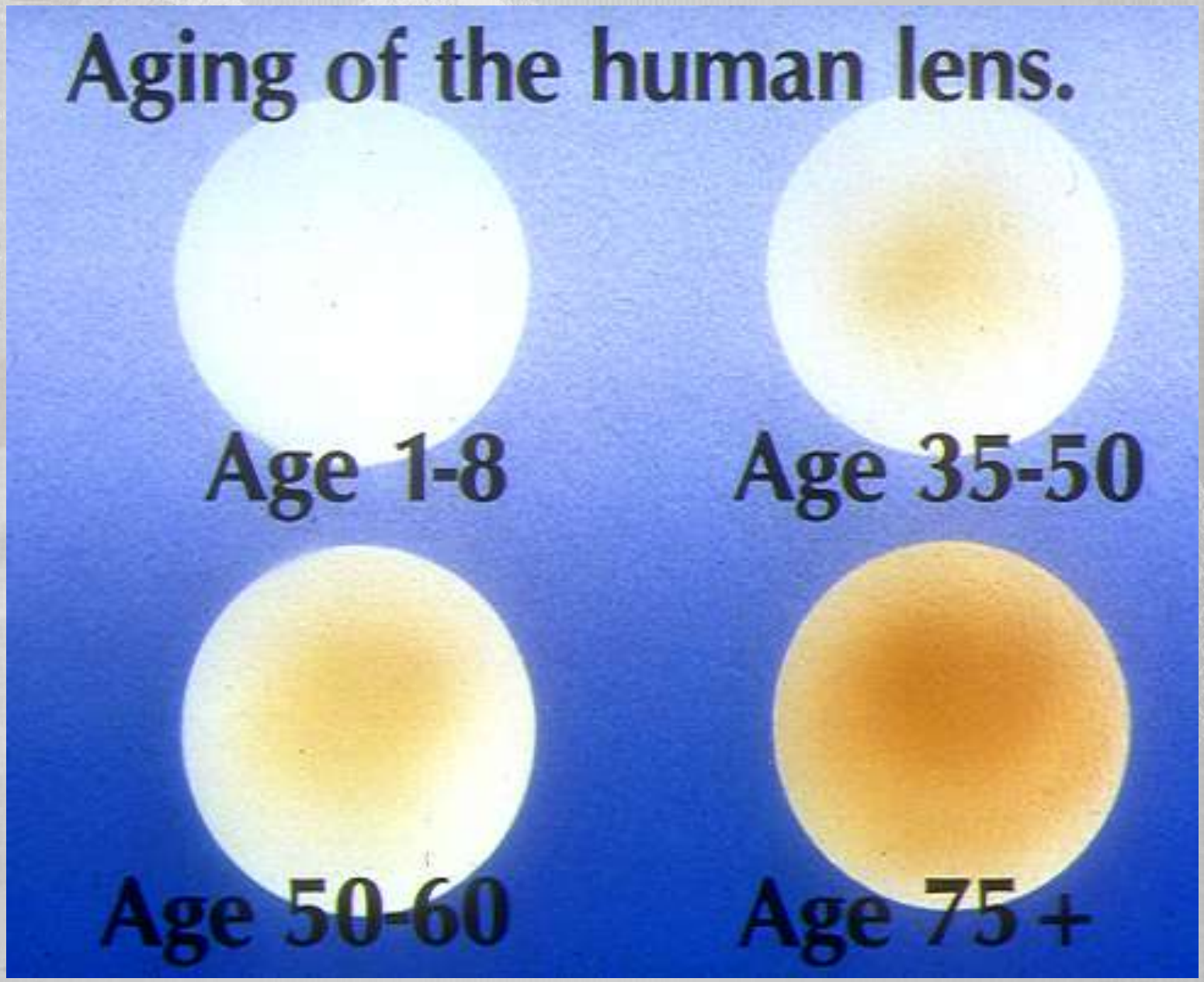
ESTA HISTORIA COMIENZA CON LA CIRUGIA DE LA CATARATA…

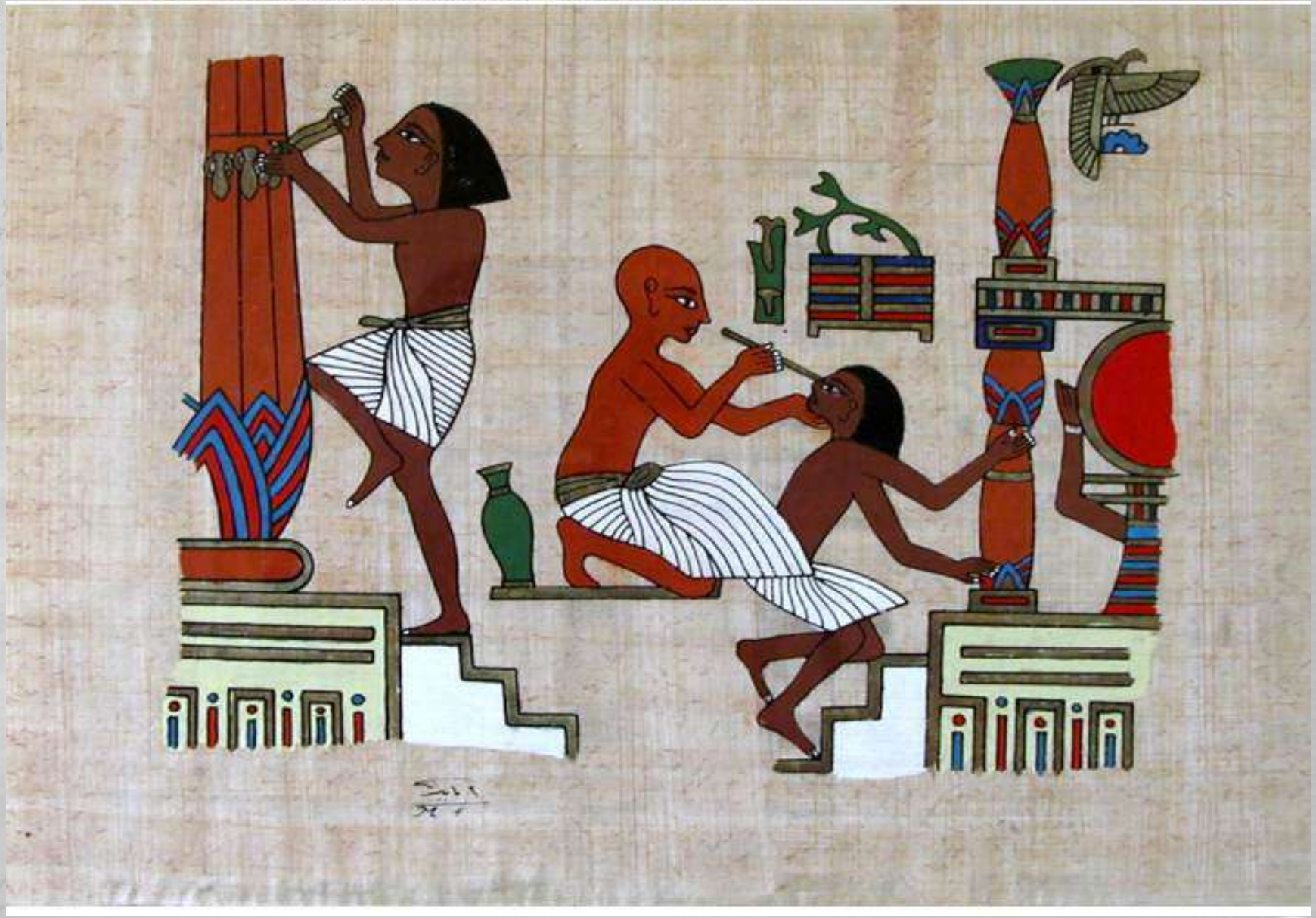


CATARATA:“El agua blanca que cae…”

CATARATA


Esclera
Coroides
Retina
Córnea
Fóvea (mácula)
Pupila
Cristalino
Nervio óptico
Iris
Cuerpo ciliar


Aging of the human lens.
Age 1-8
Age 35-50
Age 50-60
Age 75 +



(circa 1800 a. C)

The oculist **Path-Anj** and his son the scriba Ipepi. One of the first times the God of the Eye Care , **Dwaw**, is mentioned and figured .

The simbol of the profession of Ophthalmologist appears for the first time.

Dinasty XII-XIII, 1800 a.C. End of middle Kingdom.
(Private collection,Alicante)

Código de Hammurabi (1800 ac):

No describe el método curativo empleado.

Establece el pago en sheckels de plata.

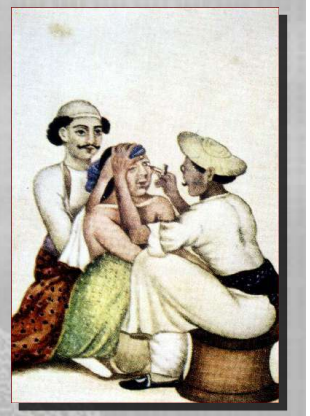
Marca sanciones severas (hasta amputación de las manos) para los cirujanos cuyos pacientes padecían complicaciones postoperatorias.

Cirugía de la Catarata
Manuscritos Sánscritos (1000 ac)

* Cirujano hindú: Susruta.
* Samhita Uttara Tantra.
* Método “couching” (reclinación).
* Desplazamiento del cristalino hacia la cavidad vítrea.
* Visión mejorada, borrosa.
* Inviabilidad de lentes correctoras.
* Inflamaciones severas.

El concepto…

HISTORIA DE LA CIRUGIA DE LA CATARATA

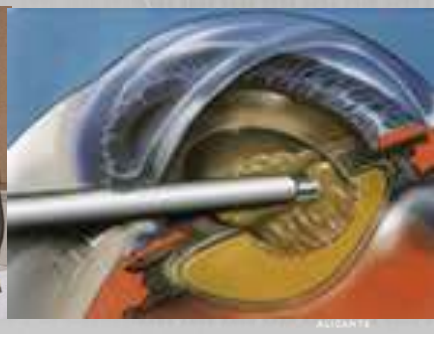


- **SUSHRUTA** REALIZO LA RECLINACION, 800 BC
  - SUSHRUTA SAMHITA

- **JACQUES DAVIEL** EXTRACCION EXTRACAPSULAR, 1747

- **CHARLES KELMAN Concepto de pequeña incision**

Creador de la Facoemulsificacion, 1967



Pero la cirugía de la catarata dejaba un ojo mutilado….

- El cristalino en reposo tiene una potencia de mas de 20 dioptrias, *que corresponden a una graduación en gafa de 13-14 dpt…*
- Además, se *pier*de la capacidad de enfocar a distintas distancias (acomodación)
- Se pierde un *volumen intraocular que al no ser repuesto modifica las relaciones anatómicas del ojo, con frecuentes complicaciones postoperatorias*

La cirugía de la catarata al principio del siglo XX

- La *extracción intracapsular* era el procedimiento mas practicado
- La *extracción extracapsular* era usada raramente en Europa
- Las *suturas* eran primitivas
- Los *microscopios no existían*, los cirujanos expertos usaban de vez en cuando gafas magnificadoras
- Los cirujanos tenían que *rehabilitar los pacientes afáquicos mandando* ***gafas muy gruesas***

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Las gafas del afaquico…

Corrección monolateral de la afáquia: Lentes de contacto?

- Lentes de contacto esclerales
- Muy incómodas
- Escasa tolerancia

¿Como resolver el problema de la potencia que eliminamos con el cristalino?

- **SIR HAROLD RIDLEY***…Inicio una nueva era***…**
  Implanto la primera lente intraocular,1949

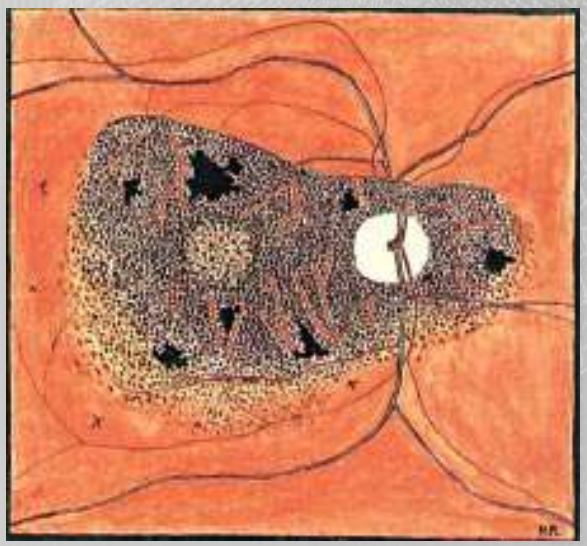
SIR HAROLD RIDLEY (I)

- Nació en Kibworth (Leicestershire) el 10 de Julio de 1906
- Descendiente de una familia de doctores y curas
- Antiguo dicho familiar: "***Do it and it´s done***"
- Graduado con honores en 1927, en el Pembroke College de la Universidad de Cambridge
- Realizó las prácticas de medicina en el hospital de St Thomas (London), en 1927 con nivel académico sobresaliente
- *FRCS a los 25 años*, la edad más joven posible

SIR HAROLD RIDLEY (II)

- Harold estuvo rodeado rodeado por los mejores cirujanos oftalmologos desde el principio de su carrera
- De todas formas, antes de empezar a estudiar oftalmología decidió de trabajar como cirujano de la Marina Real (1933-1934)

Fig. 2. Harold Ridley, Major, Royal Army, in Ghana, circa 1941. Ridley (right) is in the village of Funsi, performing investigations on onchocerciasis (river blindness).



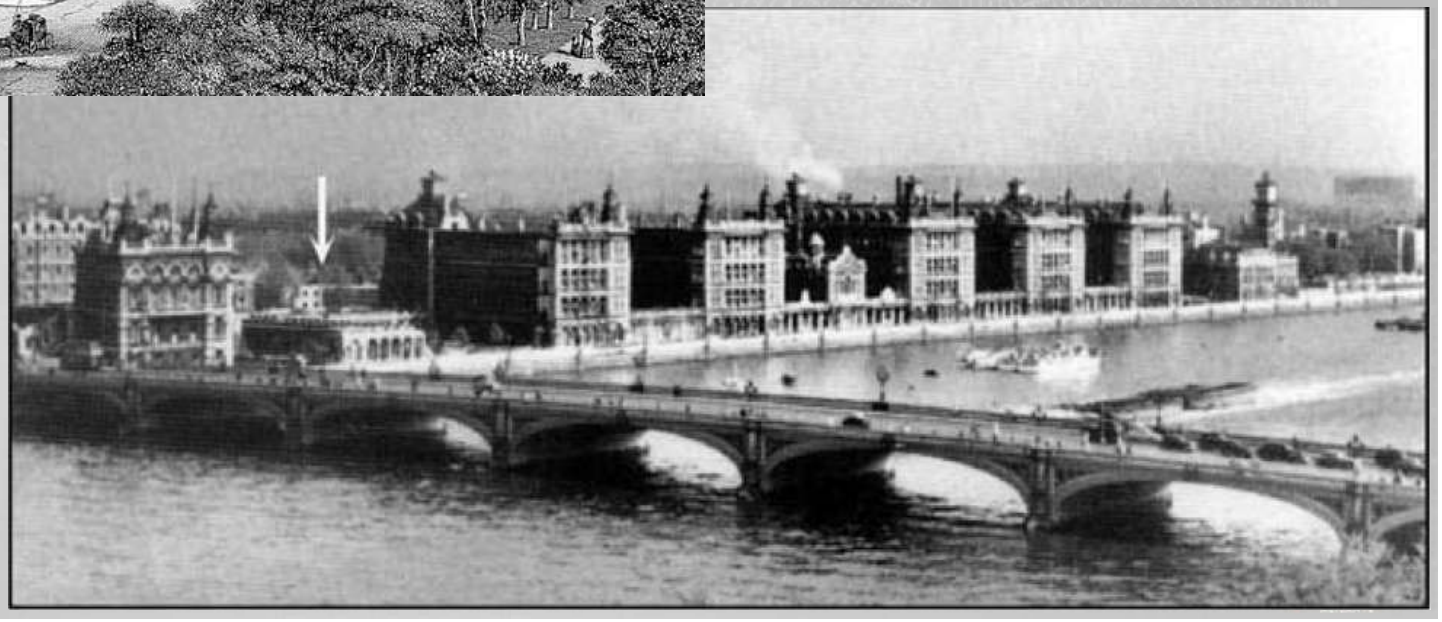
SIR HAROLD RIDLEY (III)

- **1934-35**, completó un periodo de 18 meses de residencia de oftalmología en el Moorfields Eye Hospital. Realizó 100 extracciones de catarata, todas Intracapsulares…
- 1938, cirujano a tiempo completo y adjunto en el Moorfields Eye Hospital
- **Segunda Guerra Mundial**, **1939**: el servicio de oftalmología fue evacuado por los ataques de la Luftwaffe. ***Su nueva instalación fue realizada cerca del aeropuerto Tangmere de la RAF.***

St Thomas' Hospital 1871

Figure 1 - Dr. Harold Ridley(original from 1950)

St Thomas Hospital, hacia 1939…



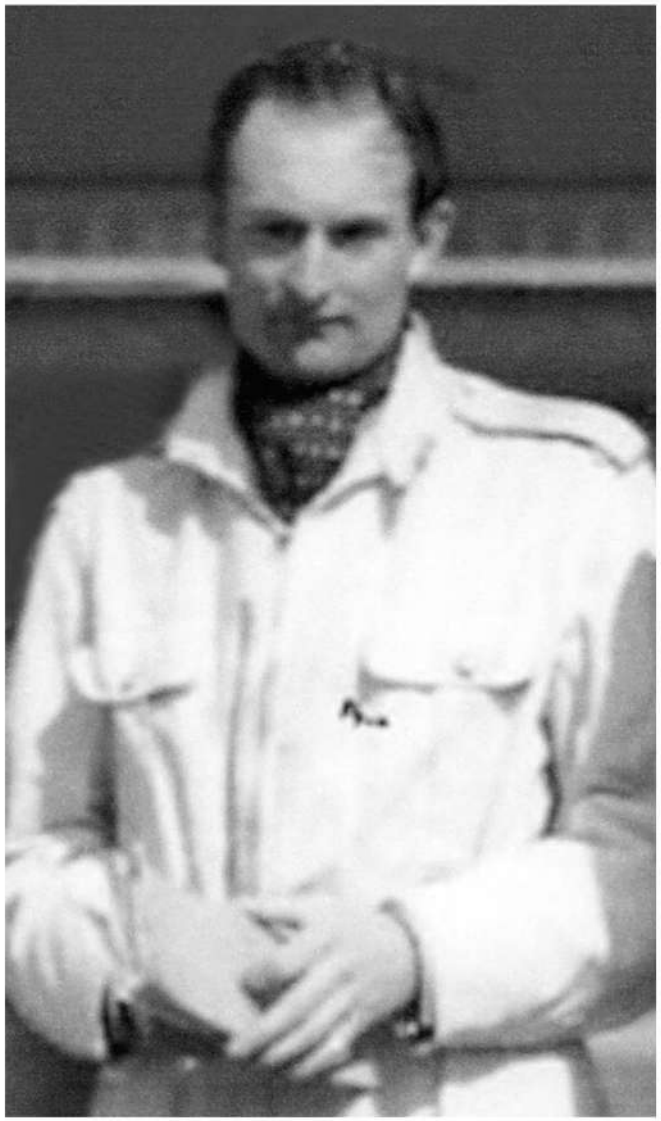
Sala de Oftalmologia , St Thomas Hospital, 1939

Sala de Oftalmologia , St Thomas Hospital, 1940

La oportunidad de una observacion casual…

- El **14 de agosto de 1940** un piloto de guerra de Hurricane del esquadrón 601, tuvo lesiones en ambos ojos durante el combate: el **teniente piloto aviador Gordon Cleaver** retuvo material acrílico Perspex en la explosión de la carlinga
- *Perdió el ojo izquierdo y el derecho recuperó parte de visión después de muchas intervenciones quirúrgicas,* ***algunos de los cuerpos estraños no pudieron removerse del ojo****…*

ENTONCES RIDLEY OBSERVO LA BUENA BIOTOLERANCIA DEL MATERIAL



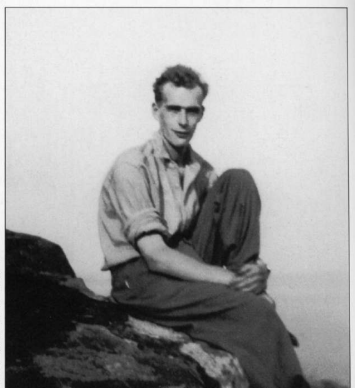
El teniente piloto aviador Gordon 'Mouse' Cleaver, del escuadrón 601, RAF Tangmere. Ridley notó muchos pilotos con el mismo tipo de lesión y esto fue fundamental por la invención de la LIO. De todas formas, Cleaver es el único piloto cuyos informes sean disponibles.

Harold Ridley al final de lo años 1940. Ridley reconoció la importancia de las lesiones de Cleaver cerca de su idea de LIO, y esto empezó la cuenta atrás que se finalizó con la invención de la LIO.

Ridley's crucial observation that perspex did not cause a foreign body reaction in the eye

COMO NACIÓ LA IDEA EUREKA!

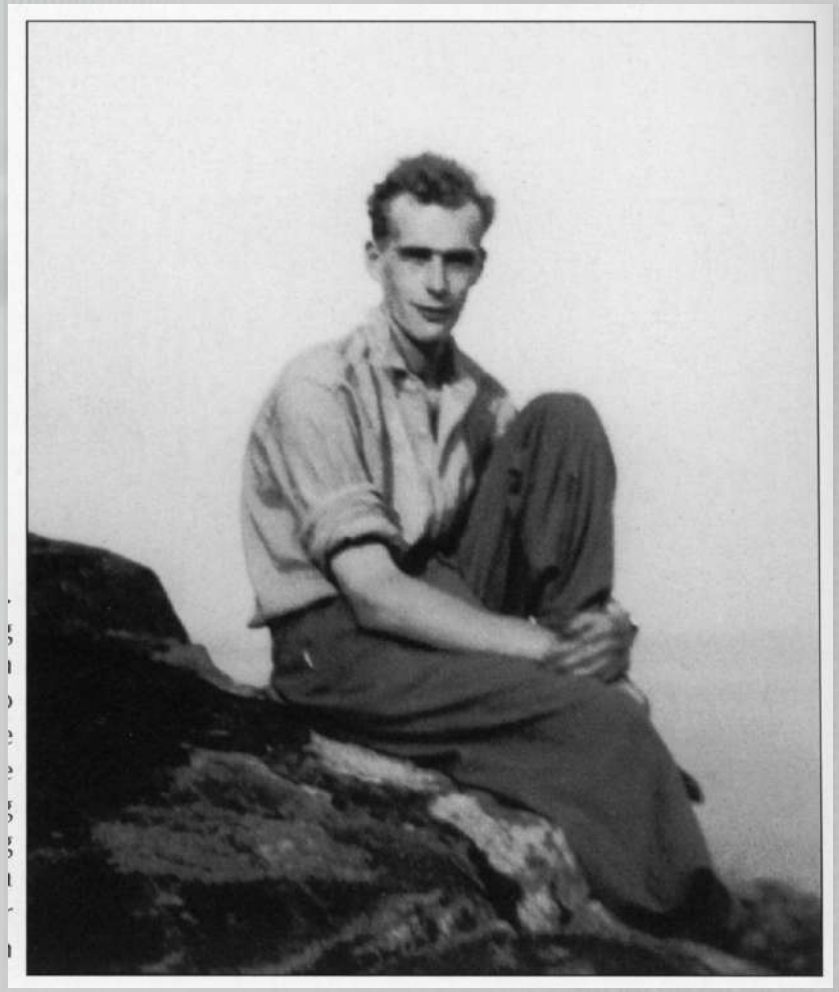
- *Ridley estaba elaborando la idea de una susitución de lente desde el 1935*
- Hay evidencia que el habló de la idea de una lente artificial o de un transplante de lente con su padre y con su profesor Mr. Hudson
- Él creía que este transplante completara la intervención de catarata que entonces se hacia
- La pregunta puesta por **el estudiante de medicina Stephen Perry en 1948** enfatizó la idea



El estudiante de medicina

Stephen Perry

'¿Dr Ridley, porqué no pone una nueva lente en el ojo?



Comienza el desarrollo del concepto…

- **Ridley creo un equipo** que le ayudó a diseñar y luego fabricar una lente intraocular:
  - **Mr John Pike**, científico de óptica
  - **Rayner & Keever Ltd**, compañía óptica especializada en fabricación de gafas
- **Perspex (PMMA)** fue el material elegido, Pike hizo los cálculos ópticos
- Imperial Chemical Industries (ICI), proporcionó **material acrílico** de alta calidad: el Perspex CX

Rayner

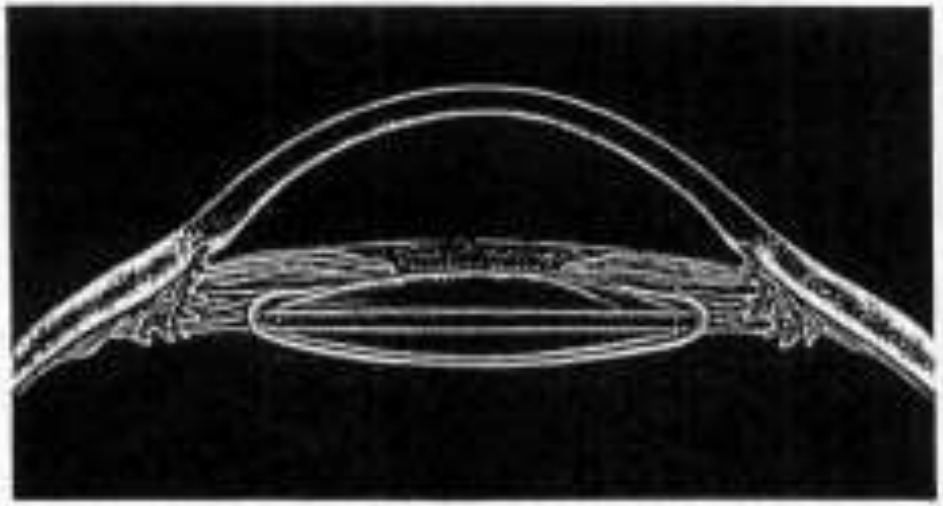
Dispensing Opticians

Members of the Association of Dispensing Opticians

AN ACRYLIC INTRA-OCULAR LENS

At the Oxford Ophthalmological Congress, July 6th, 1951, and in the March 1952 issue of the British Journal of Ophthalmology, Mr. Harold Ridley described the introduction into the eye, in the place of the crystalline lens removed for cataract, of a substitute crystalline lens made from Perspex.

A



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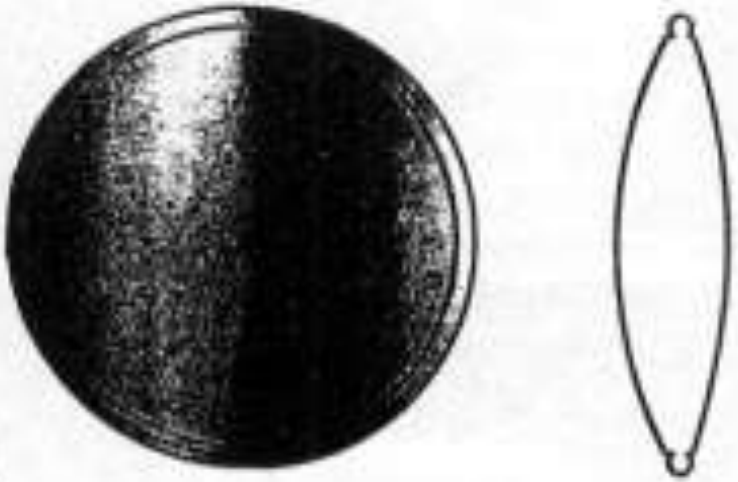

LA PRIMERA CIRUGÍA CON LIO

- Se planteó el **primer implante de LIO en el mundo** el **29 de noviembre de 1949** en el Hospital de St Thomas.

- Fueron seleccionados 2 pacientes voluntarios

La intervención fue realizada por la tarde con una simple luz de linterna…

- La paciente finalmente elegida fue una enfermera de 45 años, **Elisabeth Atwood**, qué tenía una catarata monocular.

LA PRIMERA CIRUGÍA CON LIO

- Se realizó una extracción extracapsular
- No consta que hubiera complicaciones
- No se tomaron ni fotos, ni pelicula…
- El implante de la lente intraocular LIO no se mencionó en el libro de quirofano …
- **El implante de la 1ª LIO fue un secreto !!!**
- Otros 5-6 pacientes fueron implantados poco despues

COMO FUE EL PRIMER IMPLANTE DE LIO

- Extracción extracapsular
- Probablemente una intervención secundaria
- No fue grabado
- Sin problemas ?
- Complicaciones tardias???

La primera intervención de Ridley

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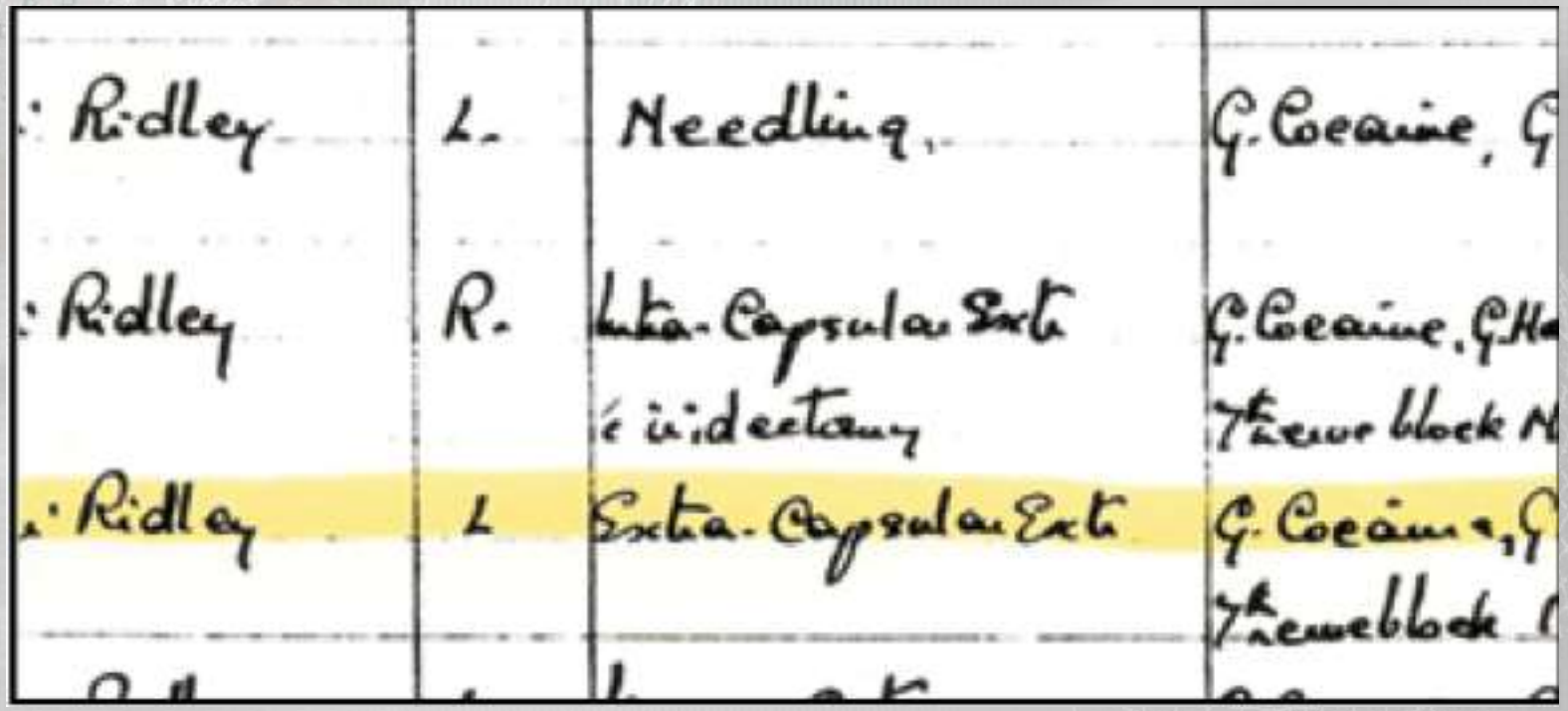
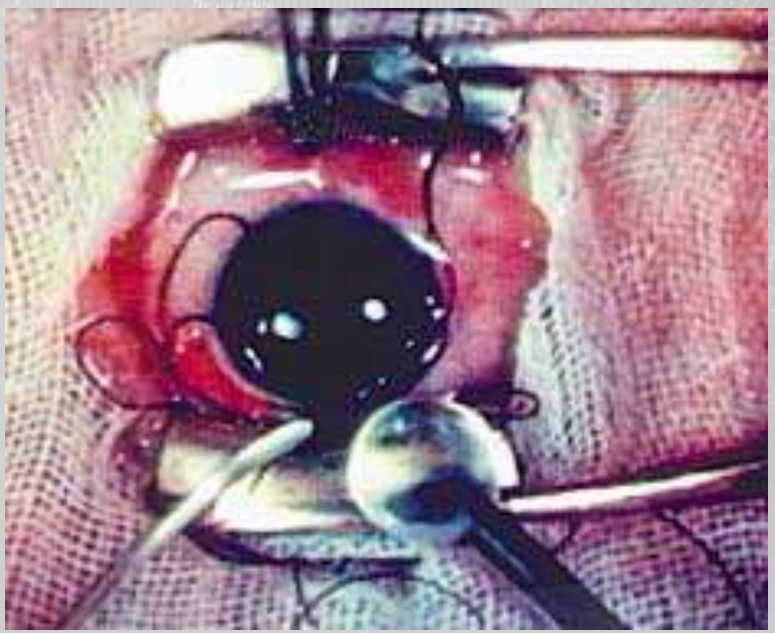


: Ridley	L.	Needling.	G. Cocaine, G
: Ridley	R.	Extra-Capsular Extr é with cataract	G. Cocaine, G. He 7th new block N
: Ridley	L	Extra-Capsular Extr	G. Cocaine, G 7th new block

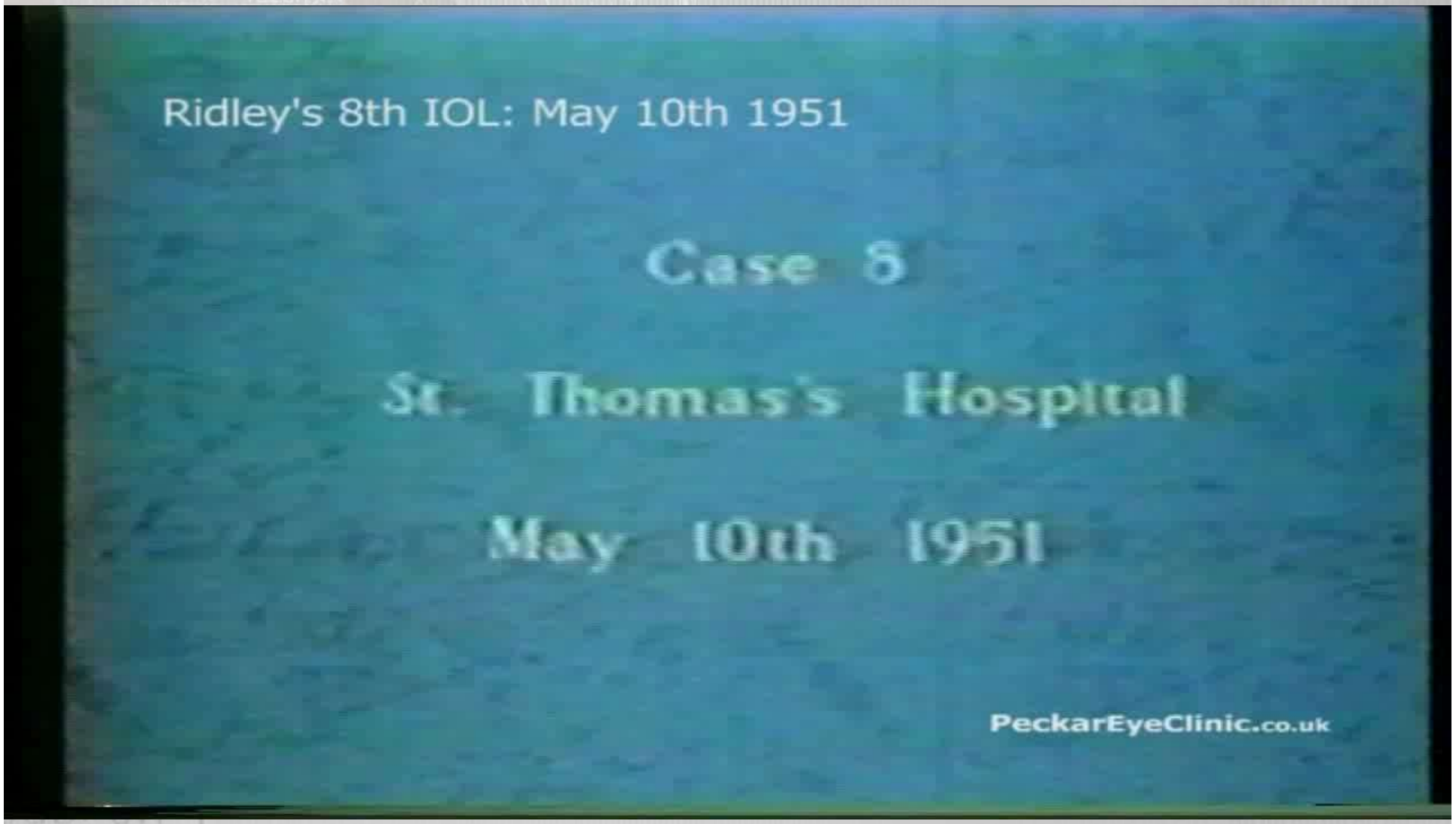
El primer implante de LIO fue un procedimiento secundario

- En 3 meses la cápsula se habría “espesado” y habría sostenido la LIO, permitiendo el éxito anatómico del implante



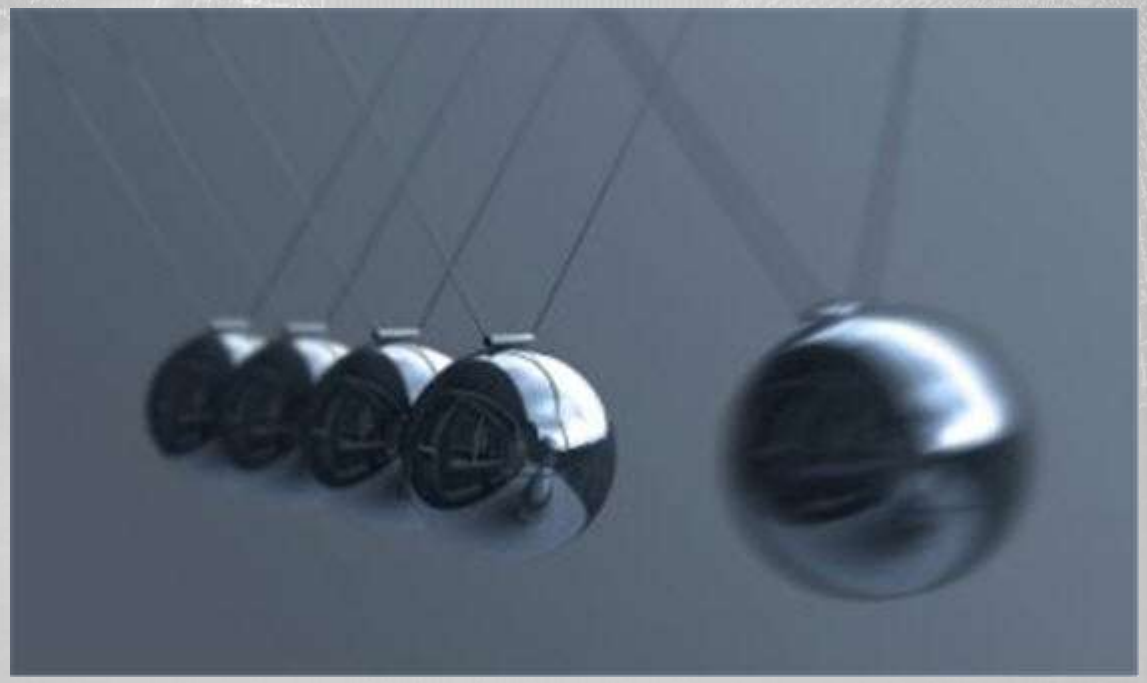

Ridley
L.
Lentículas Graff
Ridley
L
Lentículas Graff
Reparación

Fig. 1. Harold Ridley, circa 1950, at the time of the first IOL implantations.


Ridley's 8th IOL: May 10th 1951
Case 8
St. Thomas's Hospital
May 10th 1951
PeckarEyeClinic.co.uk

EL PROGRESO DE LA IDEA…

…Y LA RESISTENCIA A ÉSTA!!



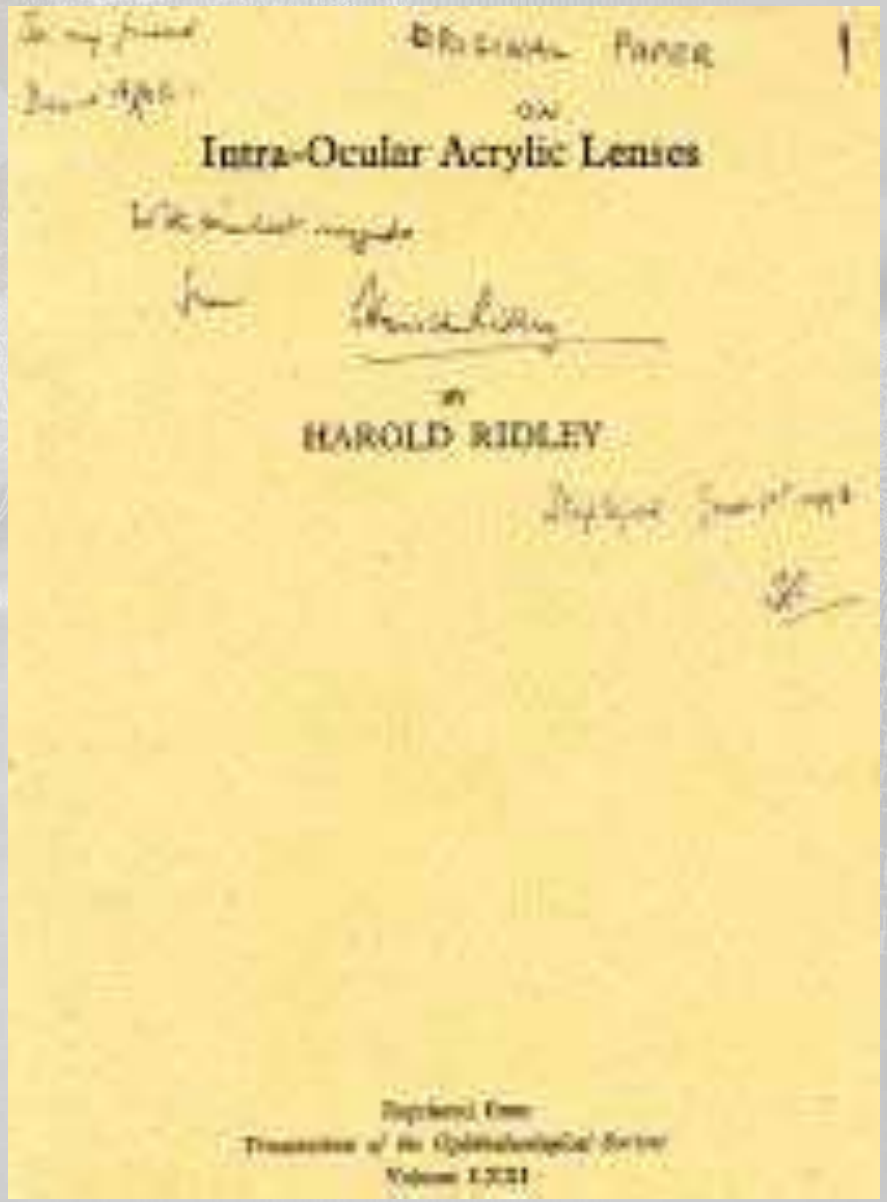
LAS PRIMERAS CIRUGÍAS CON LENTE INTRAOCULAR

….Nunca se hizo una declaración pública del hecho.

La primera publicación en el *St Thomas' Hospital Reports (1951)*, fue seguida por una en *Transactions of the Ophthalmological Society of the United Kingdom (1951)*, una en *The Lancet (1952)*, y la tercera en el *British Journal of Ophthalmology* (1952)

La *primera presentación importante fue al Oxford Ophthalmological Congress en Julio de 1951*, al Balliol College.

Se llevó dos pacientes implantados al Congreso



Reprinted Paper

on

Intra-Ocular Acrylic Lenses

by

HAROLD RIDLEY

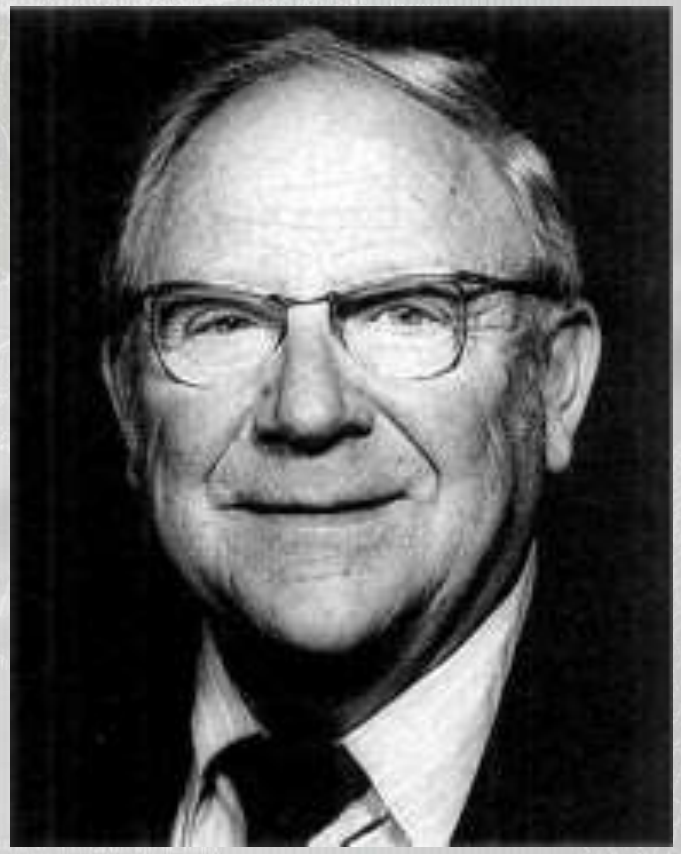
Reprinted from
Transactions of the Ophthalmological Society
Volume LXXI

LOS SEGUIDORES

- Peter Choyce
- Edward Epstein
- Svyataslav Fyodorov

Lo apoyaron durante una tormenta de reacciones en contra…

No tuvo reconocimientos públicos hasta la creación del IIIC después del primer "intraocular implant meeting" celebrado en **1974** durante el International Congress of Ophthalmology como sesión satélite



D. Peter Choyce,

Inglés, participó en las primeras intervenciones y fue colega y seguidor de Ridley.

Choyce and Ridley fueron fundamentales para mantener vivo el implante de LIO en un momento crucial, cuando el futuro de esta intervención estaba en duda – sobre todo durante una sesión del International Congress of Ophthalmology de Paris en 1974.

Miembros fundadores del International Intraocular-Implant Club (IIIC), 14 de Julio de 1966, Londres.

De izquierda á derecha, primera fila: Lurie Boberg-Ans, Cornelius Binkhorst, Peter Choyce, Harold Ridley, Strampelli, Edward Epstein, and Mrs. Boberg-Ans. Segunda fila, de izquierda á derecha las,Brown,Rubenstein, Warren Reese and Lurie.

RECONOCIMIENTOS

- 1979 Intraocular Lens Implant Society (hoy ASCRS)
- 1986 Fellowship of the Royal Society of UK
- 1989 Honorary Doctorate, Medical University of South Carolina
- 1999 Ophthalmology Hall of Fame, ASCRS

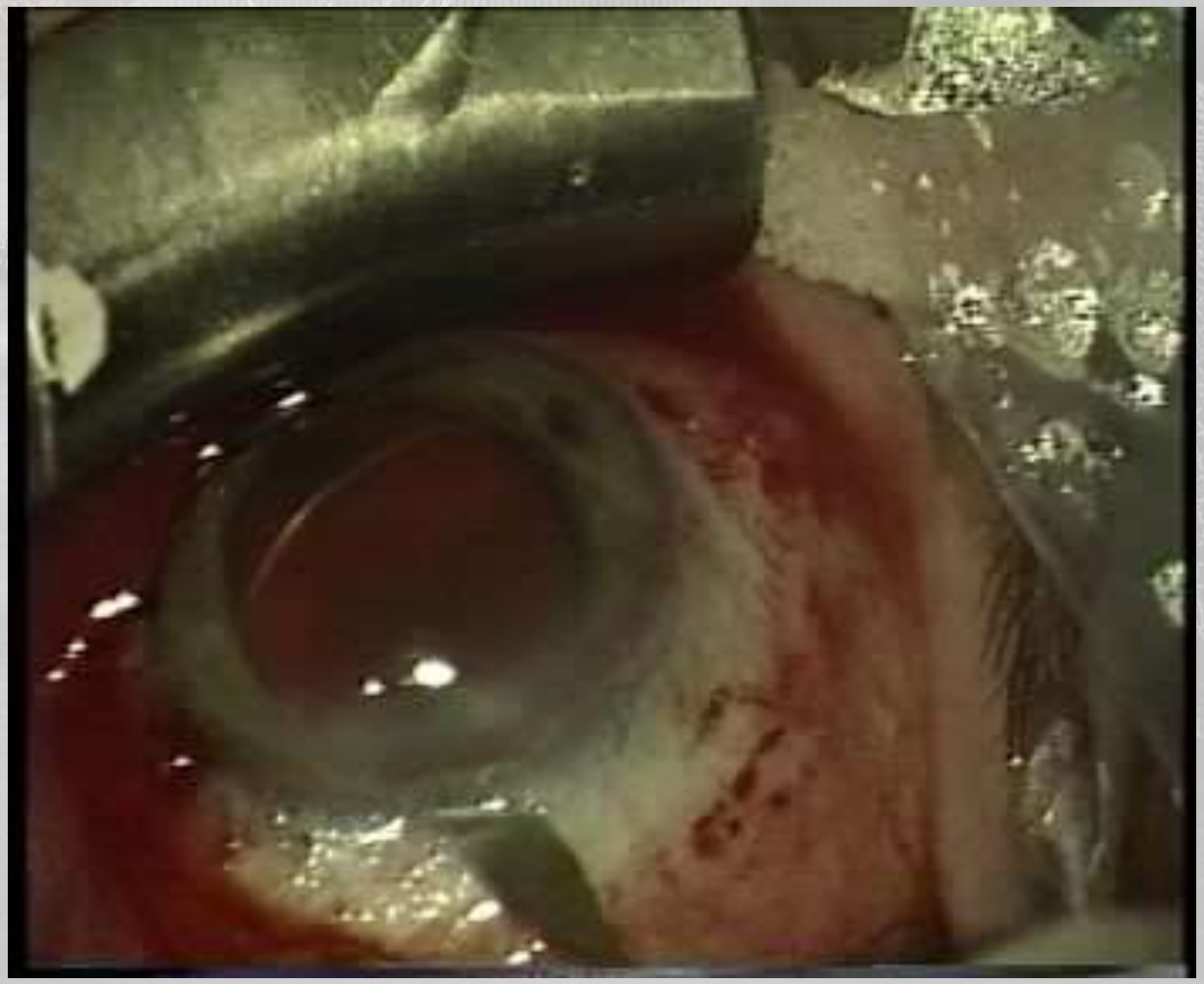
Nombrado caballero del Imperio Británico por la Reina Isabel II en Buckingham Palace el 9 de febrero de 2000 a los 92 años

RECOGNITION

La Reina Isabel II confiriendo el título de caballero a Sir Harold en 2000.

Pero las lentes intraoculares eran rígidas …..

Necesitaban incisión de 7mm



Después fueron plegables…

Necesitaban incisión de 3.5mm

Después se pudieron ya inyectar…

Necesitaban incisión de 1.8mm

Incluso llegaron a poderse enrollar !!!

Necesitaban incisión de 1mm

Pero no seran perfectas hasta que …

- Puedan *implantarse por incisiones minima…1 mm*
- *Permitan enfocar* (restaurar la acomodacion)
- O al menor permitan obtener varios focos (Lejos, 6mt, Intermedio, 70cm. Cerca, 40 cm)

LA CIRUGÍA DE CATARATA IDEAL (El sueño del cirujano del siglo XXI)

- *Minimamente invasiva* (Punción)
- *Precisa, segura, controlable y eficaz* en todos los casos de cataracta
- La LIO tendría que *corregir todos los tipos de defectos refractivos previos,* con precisión
- La LIO tendría que *restaurar la acom*odación
- Uso de *ópticas especiales* en casos con necesidad de mejorar la vision ?

LAS MODERNAS LENTES INTRAOCULARES (I)

Restauracion de la capacidad de enfoque a diferentes distancias ::

- LENTES MULTIFOCALES : Restauran la polifocalidad

- LENTES ACOMODATIVAS : Restauran la acomodacion

LAS MODERNAS LENTES INTRAOCULARES (II)

:

LENTES MULTIFOCALES

- La multifocalidad no es fisiologica, pero hasta el momento es la única alternativa a la presbicia pseudofáquica

- Progresos recientes en el diseño óptico del las LIOs multifocales han aumentado las prestaciones en los modelos mas recientes





EL ESTUDIO MODERNO DE UNA LENTE INTRAOCULAR

- **OPTICAL BENCH ANALYSIS:** IOL quality
- **INTRAOCULAR OPTICAL QUALITY**: Provides information about the **retinal image** caused by the lens.
- **DEFOCUS CURVE OF THE LENS** : Provides information about the **neuroprocessing** of the differenf foci at different distances. Correlates well with the quality of vision as **perceived by the patient** in terms of multifocality. It should be provided on monocular basis

MODERN MULTIFOCAL IOLs CHOICES

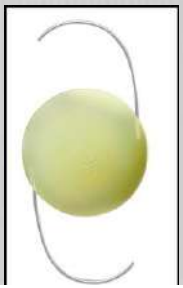
- **Diffractive:** - Bifocal
  -Trifocal



- **Refractive:** - Rotational Symetrical
  - Sector (Zonal refractive)


- **Hybrid**
- **Pupil Indepent/ Dependent**

- **Add-on MF IOL´s**

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Optical Performance of Multifocal IOLs on an Optical Bench

Geunyoung Yoon, PhD

Scott McRae

Jorge L.Alio

Flaum Eye Institute, The Institute of Optics, Center for Visual Science, Biomedical Engineering University of Rochester (USA) & VISSUM Instituto Oftalmologico de Alicante (SPAIN)

ORIGINAL ARTICLE

Correlating Optical Bench Performance With Clinical Defocus Curves in Varifocal and Trifocal Intraocular Lenses

Ana B. Plaza-Puche, MSc; Jorge L. Alió, MD, PhD; Scott MacRae, MD; Len Zheleznyak, PhD; Esperanza Sala, OD; Geunyoung Yoon, PhD

ABSTRACT

PURPOSE: To investigate the correlations existing between a trifocal intraocular lens (IOL) and a varifocal IOL using the "ex vivo" optical bench through-focus image quality analysis and the clinical visual performance in real patients by study of the defocus curves.

METHODS: This prospective, consecutive, nonrandomized, comparative study included a total of 64 eyes of 42 patients. Three groups of eyes were differentiated according to the IOL implanted: 22 eyes implanted with the varifocal Lentis Mplus LS-313 IOL (Oculentis GmbH, Berlin, Germany); 22 eyes implanted with the trifocal FineVision IOL (Physiol, Liege, Belgium), and 20 eyes implanted with the monofocal Acrysof SA60AT IOL (Alcon Laboratories, Inc., Fort Worth, TX). Visual outcomes and defocus curve were evaluated postoperatively. Optical bench through-focus performance was quantified by computing an image quality metric and the cross-correlation coefficient between an unaberrated reference image and captured retinal images from a model eye with a 3.0-mm artificial pupil.

RESULTS: Statistically significant differences among defocus curves of different IOLs were detected for the levels of defocus from -4.00 to -1.00 diopters (D) ($P < .01$). Significant correlations were found between the optical bench image quality metric results and logMAR visual acuity scale in all groups (Lentis Mplus group: $r = -0.97$, $P < .01$; FineVision group: $r = -0.82$, $P < .01$; Acrysof group: $r = -0.99$, $P < .01$). Linear predicting models were obtained.

CONCLUSIONS: Significant correlations were found between logMAR visual acuity and image quality metric for the multifocal and monofocal IOLs analyzed. This finding enables surgeons to predict visual outcomes from the optical bench analysis.

[*J Refract Surg.* 2015;31(5):300-307.]

Several multifocal intraocular lens (IOL) designs are available for restoring distance and near vision simultaneously.[1] Different studies have confirmed the efficacy of multifocal IOLs to provide good functional vision without the use of corrective lenses.[1,2-6] However, optical side effects such as decreased contrast sensitivity, glare disability, or halos have also been reported.[7-10]

Recently, two new multifocal IOL technologies have been introduced into clinical practice: the varifocal IOL and the trifocal multifocal IOL. The Lentis Mplus (Oculentis GmbH, Berlin, Germany) varifocal IOL includes an inferior surface-embedded segment with the optical power required for near vision and seamless transitions between the near and far vision zones.[11,12] The FineVision (Physiol, Liege, Belgium)[13] trifocal IOL combines two diffractive apodized profiles that can provide three foci for distance, near, and intermediate vision.[14] Previous studies[15,16] have clinically evaluated the optical image quality of these models. These studies had some restrictions, such as pupil diameters, corneal aberrations, and ocular axis misalignments. The optical bench analysis allows assessment of the differences between IOL optics independently of factors noted previously.

From Vissum Corporation, Alicante, Spain (ABP-P; JLA, ES); Division of Ophthalmology, Universidad Miguel Hernández, Alicante, Spain (JLA); Flaum Eye Institute, University of Rochester, Rochester, New York (SM, LZ, GY); The Institute of Optics, University of Rochester, Rochester, New York (SM, LZ, GY).

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The authors have no financial or proprietary interest in the materials presented herein.

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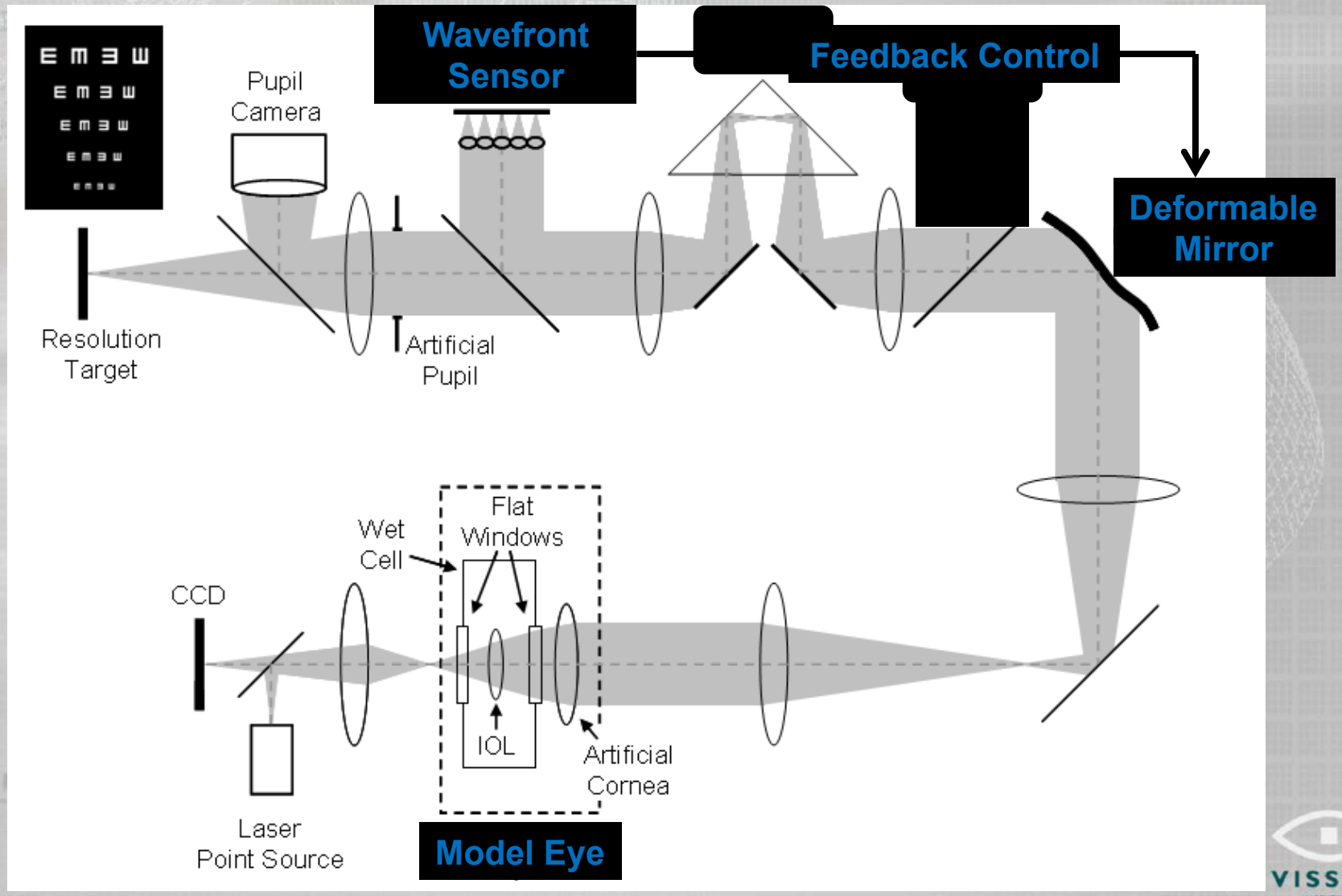
Correlating optical bench performance with clinical defocus curves in varifocal and trifocal intraocular lens.

Plaza- Puche AB, **Alió JL**, MacRae S,Yoon G. et Al

J Refract Surg. 2015 May;31(5):300-7.

Adaptive Optics (AO) IOL Optical Bench Testing System



Quantifying Image Quality: Cross-correlation Coefficient (CC)

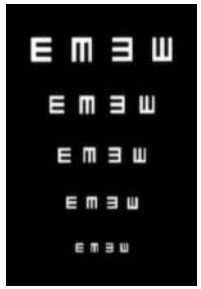
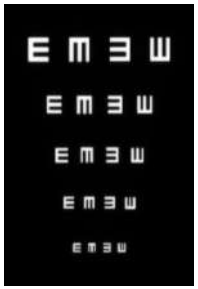
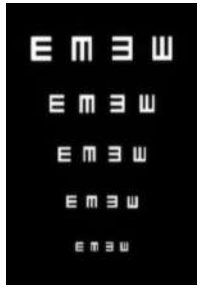
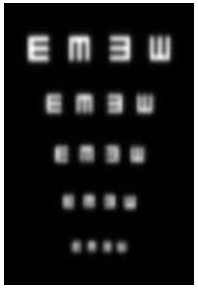
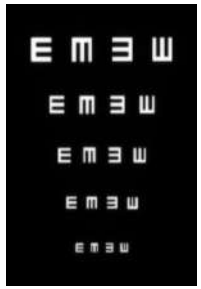
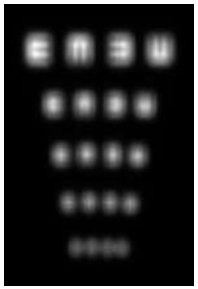
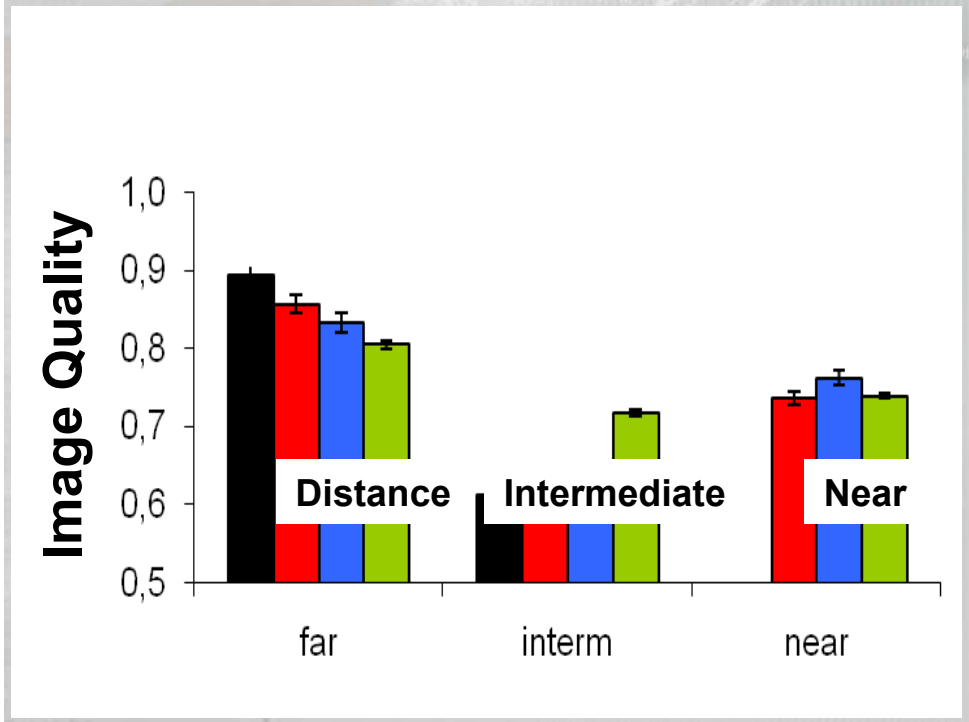
Reference		Sample		CC	
	☆		=	1	Perfect image quality
	☆		<	1	Mild blur in image
	☆		<<	1	Severe blur in image

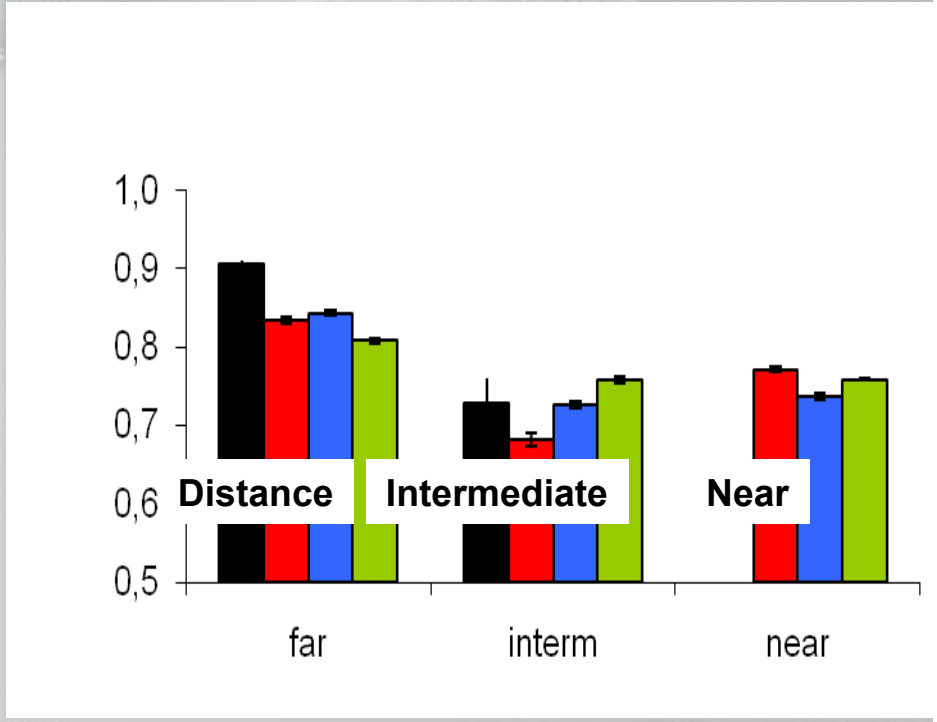
Image quality at Distance, Intermediate and Near

AcrySof ReSTOR Fine Vision Mplus 3

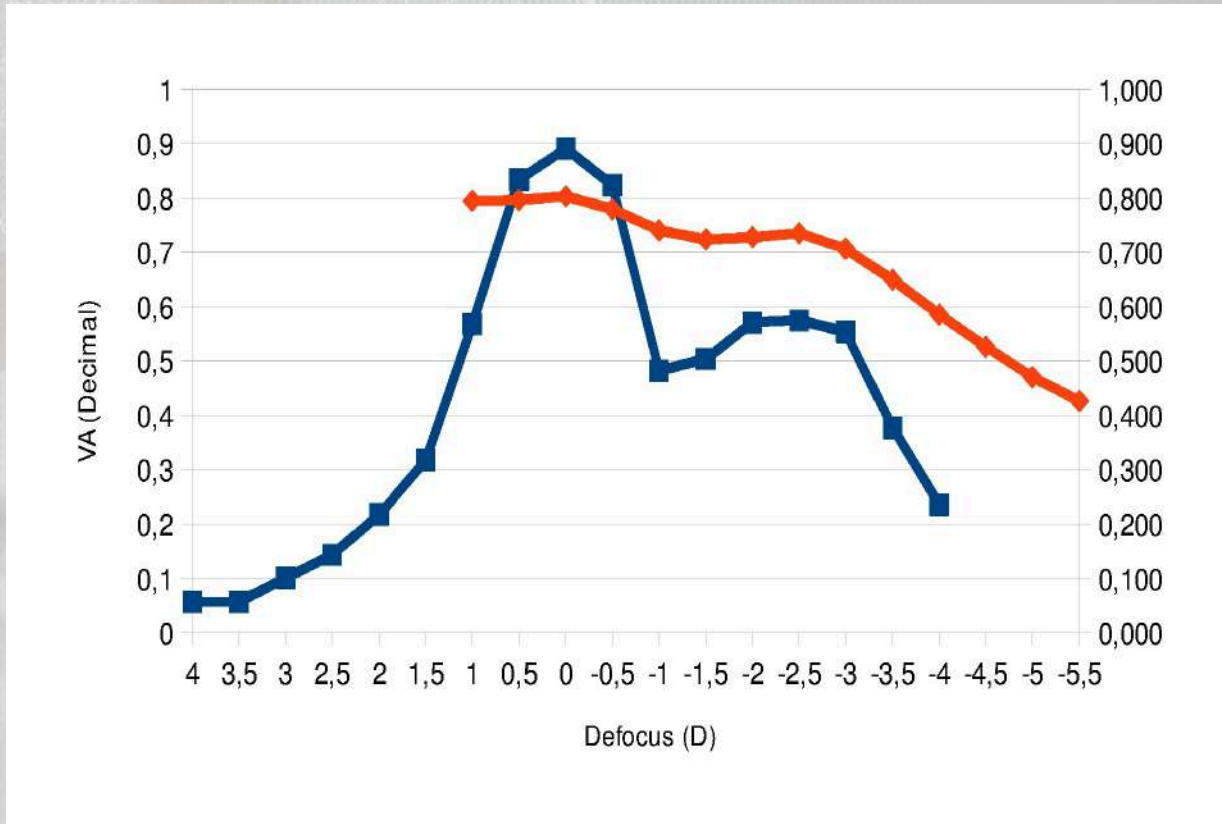
5 mm pupil



3 mm pupil

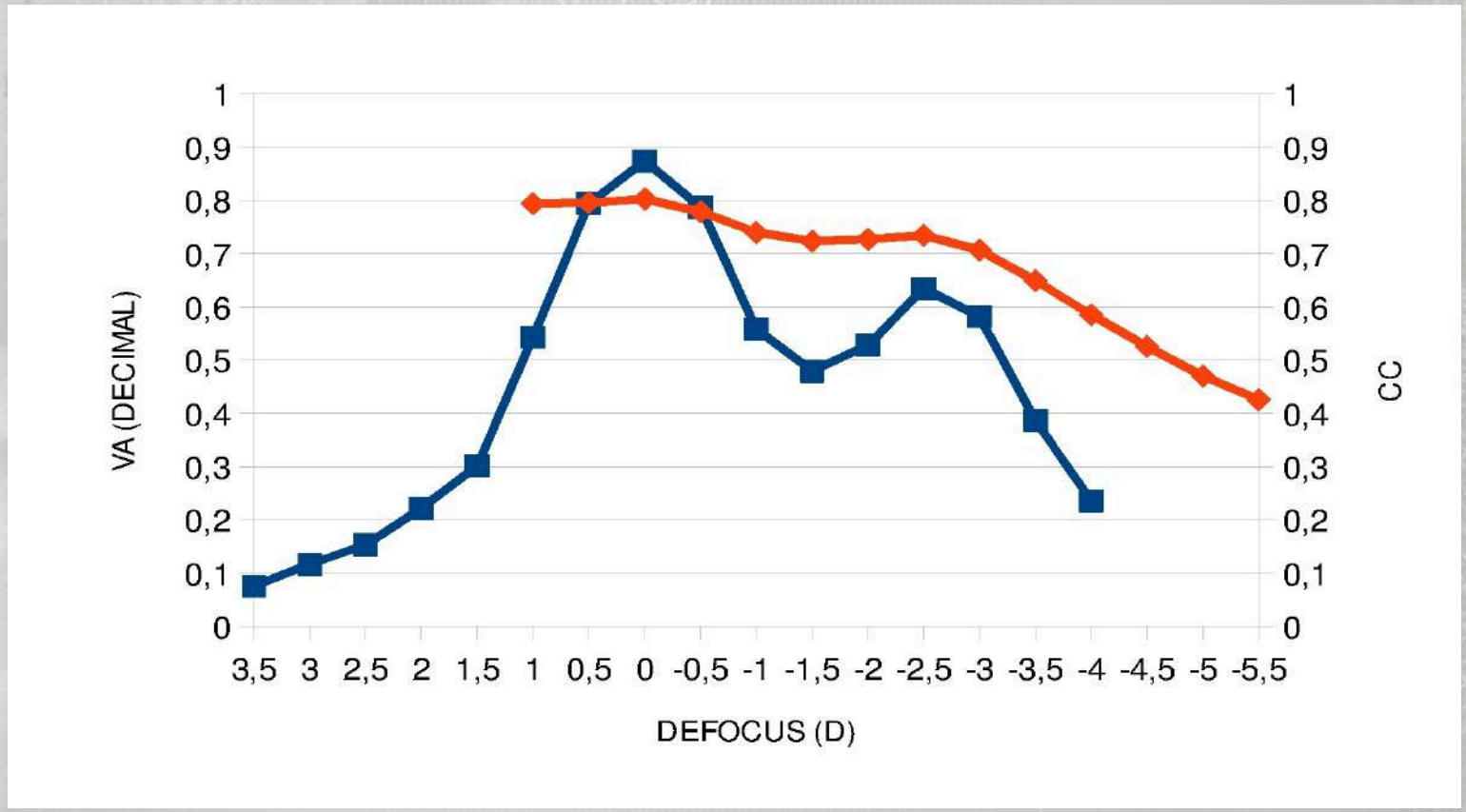


FINEVISION IOL (TRIFOCAL)



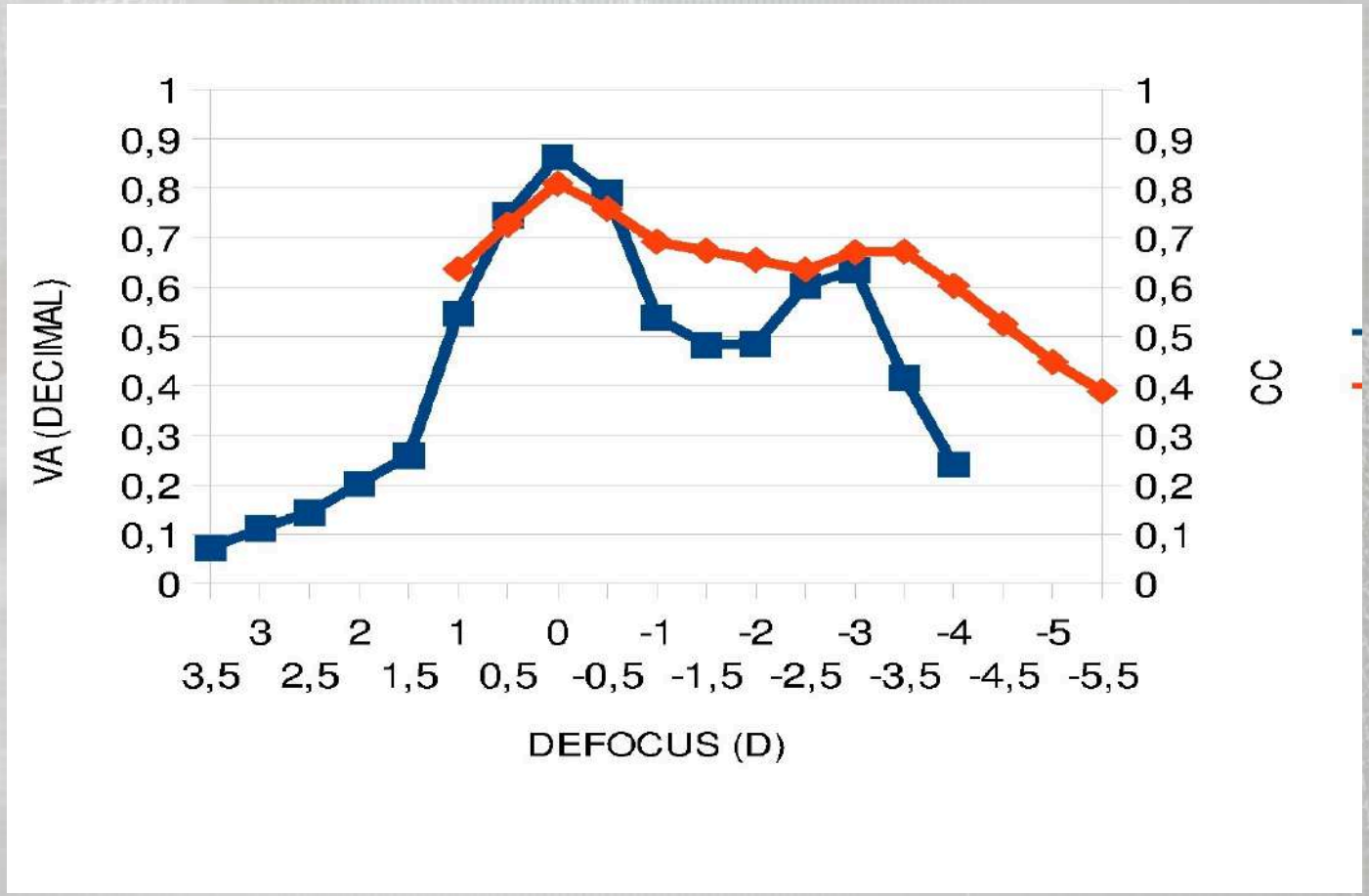
- Orange line optical bench analisys with **0D of corneal astigmatism** simulation
- Blue line, all patients analysis

FINEVISION IOL (TRIFOCAL)



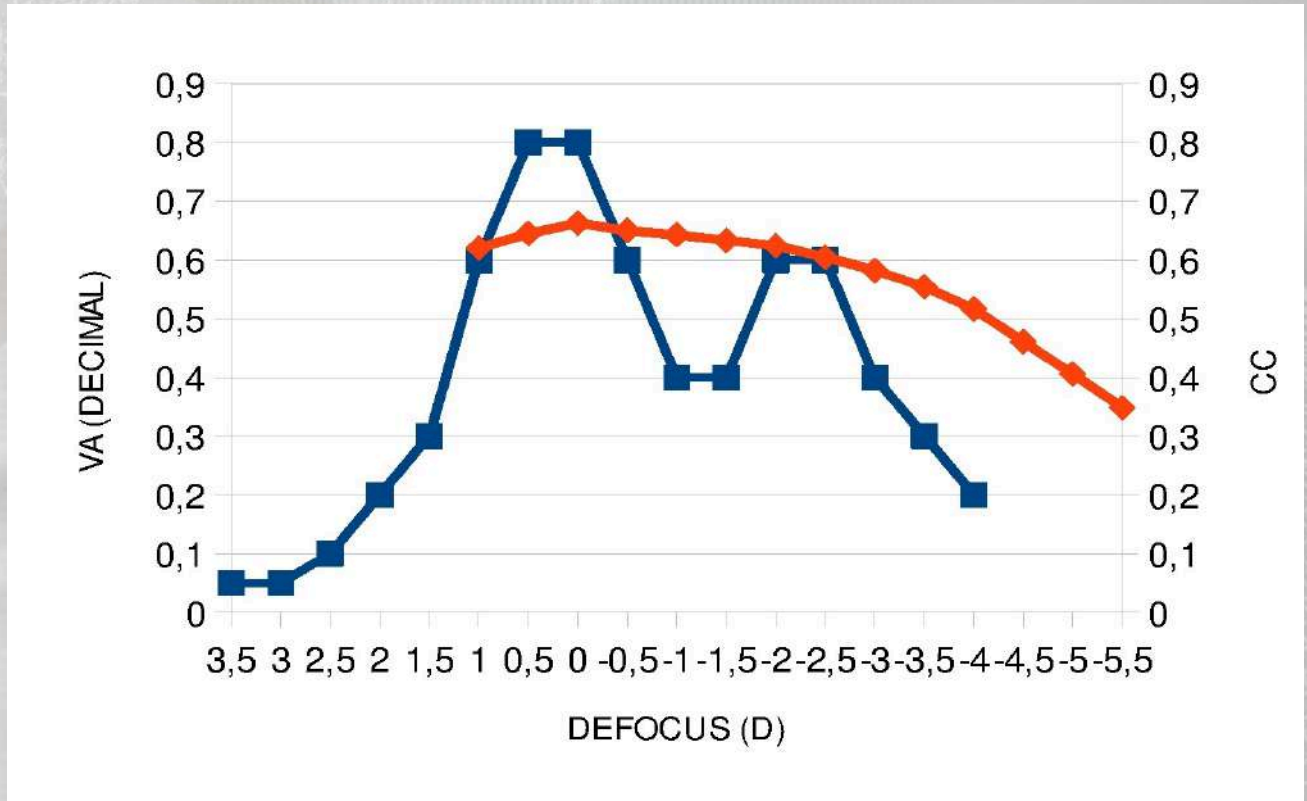
- Orange line optical bench analisys with . . .**corneal aberration free simulation**
- Blue line, all patients analysis

FINEVISION IOL (TRIFOCAL)



- Orange line optical bench analisys **with 0,14µm of corneal HOA simulation**
- Blue line patients between 0,08-0,21µm of corneal HOA analisys

FINEVISION IOL (TRIFOCAL)



- Orange line optical bench analisys **with 0,61µm of corneal HOA simulation**
- Blue line patients between 0,48-0,68µmof corneal HOA analisys -

In Vivo INTRAOCULAR PERFORMANCE OF MF IOLs

Visual and Optical Performance With Two Different Diffractive Multifocal Intraocular Lenses Compared to a Monofocal Lens

Jorge L. Alió, MD, PhD; David P. Piñero, PhD; Ana B. Plaza-Puche, MSc; Francisco Amparo, MD; Ramón Jiménez, MSc; Jose L. Rodríguez-Prats, MD, PhD; Jaime Javaloy, MD, PhD

ABSTRACT

PURPOSE: To compare the visual acuity outcomes as well as the ocular optical performance of eyes implanted with either a monofocal or one of two diffractive multifocal intraocular lenses (IOLs).

METHODS: One hundred two consecutive eyes of 51 bilateral cataract patients (age 49 to 80 years) were divided into three groups: 22 eyes were implanted with a monofocal IOL (monofocal group), 40 eyes with the Acrysof ReSTOR SN6AD3 IOL (ReSTOR group), and 40 eyes with the Acri.Lisa 366D IOL (Acri.Lisa group). Visual acuity and contrast sensitivity were evaluated pre- and postoperatively. Additionally, ocular optical quality and intraocular aberrations were evaluated postoperatively.

The goal of modern cataract surgery is to achieve fast visual rehabilitation without complications and low postoperative residual refractive errors.[1] As a result of technical progress, this type of surgery has been optimized due to the improvement in the control of the corneal incision[2-4] and the development of new intraocular lenses (IOLs) of increased quality. Aspheric[5-11] or aberration-free[12] monofocal IOLs are examples of this technological progress. However, although monofocal IOLs can provide excellent distance visual quality,[13] patients implanted with these lenses are still dependent on spectacles for near and intermediate vision. For this reason, more sophisticated designs with the ability to restore distance, intermediate, and near vision have been introduced in clinical practice, such as multifocal, bifocal, and accommodative IOLs.[14-18] Multifocal and bifocal IOLs have

Visual and Optical Performance with two Diferent Diffractive Multifocal Intraocular Lenses Compared to a Monofocal Lens. Jorge L. Alio MD PhD et al J Refract Surg. 2011 Aug;27(8):570-81

Visual outcomes and ... of a monofocal ... and a new-generation mul...

Jorge L. Alió, MD, PhD, David P. Piñero, PhD, Maria Joanna Rodriguez-Ch...

PURPOSE: To compare visual acuity outcomes and ocular and intraoc... with a monofocal intraocular lens (IOL) or a multifocal IOL with retati...

SETTING: Visumm Corporation, Alicante, Spain.

DESIGN: Comparative case series.

METHODS: Consecutive eyes of cataract patients were divided into 2 groups: a Lentis Mplus LS-312 multifocal IOL and the other an Acri.Smart 48S monofo... near visual acuities, contrast sensitivity, intraocular aberrations (ghost and defocus curves were evaluated preoperatively and postoperatively ... multifocal IOL group and 38 eyes, in the monofocal group). ... improvement in uncorrected and corrected ... near visual acuity (UDVA) postoperatively ... better uncorrected near acuity and ... curves showed significantly better ... defocus. The multifocal group ... sensitivity, coma (P... significant differ...

CONCLUSIONS: ... functional ...

Vector analysis of astigmatic change... after cataract surgery with implantation of a new toric multifocal intraocular lens

Jorge L. Alió, MD, PhD, David P. Piñero, PhD, Javier Tomás, MSc, Ana B. Plaza, MSc

PURPOSE: To analyze the astigmatic changes after cataract surgery with the implantation of a new toric multifocal intraocular lens (IOL) using the Alpins vector method.

SETTING: Vissum-Instituto de Oftalmológica de Alicante, Alicante, Spain.

DESIGN: Prospective case series.

METHODS: After cataract surgery with implantation of an AT Lisa 909M toric multifocal IOL, the visual, refractive, corneal topographic, internal astigmatism, defocus curves, and contrast sensitivity outcomes were evaluated over 6 months. Refractive astigmatic changes (target astigmatism [TA]; surgically induced astigmatism [SIA]; difference vector; magnitude of error; flattening effect; torque) were analyzed using the Alpins vectorial method.

RESULTS: The study enrolled 23 eyes (12 patients). Postoperatively, there was a significant reduction in refractive cylinder ($P<.01$) with an associated visual improvement for near ($P=.03$) and distance ($P=.01$). The magnitude of SIA vector was significantly larger than the TIA 3 months postoperatively ($P=.03$). The mean magnitude of the difference vector was 0.67 diopter (D) ± 0.51 (SD) at 6 months. The mean magnitude of error remained positive and close to zero over the entire follow-up ($P\geq.19$). The mean magnitude of torque and the mean magnitude of torque and the 6 months. Significant positive correlation was found between the magnitude of torque and the difference vector ($r \geq 0.70$, $P<.01$).

CONCLUSION: The new toric IOL restored distance and near visual function with excellent predictability to moderate to high corneal astigmatism having cataract surgery.

... financial or proprietary interest in any material or method ...

Comparative analysis of the clinical outcomes with 2 multifocal intraocular lens models with rotational asymmetry

ARTICLE

Jorge L. Alió, MD, PhD, Ana B. Plaza-Puche, MSc, David P. Piñero, PhD, Jaime Javaloy, MD, PhD, María José Ayala, MD, PhD

PURPOSE: To compare the clinical outcomes after cataract surgery with implantation of 2 models of a new rotationally asymmetric multifocal IOL to ascertain which provides better visual performance and patient satisfaction.

SETTING: Vissum Instituto Oftalmológico de Alicante, Alicante, Spain.

DESIGN: Comparative case series.

METHODS: Consecutive eyes of cataract patients were divided into 2 groups: a Lentis Mplus LS-312 MF15 IOL (with a near addition [add] power of ... Group B, a Lentis Mplus LS-312 MF30 IOL (with a near add power of ... and intermediate visual acuity outcomes were evaluated ... during a 6-month follow-up. Postoperative ... aberrations, ocular optical quality, and defocus curves ...

RESULTS: Patients ranged in age from 45 to 82 ... and corrected near visual acuities postoperatively ... Both groups had a statistically significant ... better uncorrected near visual acuities postop... significant difference between ... curves. There were no ... satisfaction, optical ...

Comparison of a New Refractive Intraocular Lens with an Inferio... Near Add and a Diffractive Mul... Intraocular Lens

Jorge L. Alio, MD, PhD,[1,2] Ana B. Plaza-Puche, MSc,[1] Jaime Javaloy, MD, PhD,[1] María José Ayala, MD, PhD,[1] Luis J. Moreno, MSc,[1,2] David P. Piñero, PhD[3]

Purpose: To compare the visual acuity outcomes and ocular optical performance of a multifocal refractive intraocular lens (IOL) with an inferior segmental near add or ...

Design: Prospective, comparative, nonrandomized, consecutive case series.

Participants: Eighty-three consecutive eyes of 45 patients (age range, 36 ... divided into 2 groups: group A, 45 eyes implanted with diffractive IOL Acri.Lisa 366D (Zeiss, Oberko... group B, 38 eyes implanted with phacoemulsification followed by IOL ...

Methods: All patients underwent phacoemulsification followed by IOL ... Distance corrected, intermediate, and near with the distance correction vis... sensitivity, intraocular aberrations, and defocus curve were evaluated ... follow-up.

Main Outcome Measures: Uncorrected distance visual acuity (UDV... (CDVA), uncorrected near visual acuity (UNVA), corrected distance near ... contrast ... intraocular aberrations, and defocus curve.

Results: ... cant improvement in UDVA, CDVA, and UNVA was ... better values of UNVA ($P<0.01$) and CDNVA ($P\leq0$...

Comparative Analysis of Clinical Outcomes Obtained With a New Diffractive Multifocal Toric Intraocular Lens Implanted Through Two Types of Corneal Incision

Peter Mojzis, MD, PhD, FEBO; David P. Piñero, PhD; Pavel Studeny, MD; Javier Tomás, MSc; Vladimir Korda, MD, PhD; Ana B. Plaza, MSc; Jorge L. Alió, MD, PhD, FEBO

ABSTRACT

PURPOSE: To analyze and compare the clinical outcomes obtained after cataract surgery with the implantation of a new multifocal toric intraocular lens (IOL) using two different types of corneal incision.

METHODS: Retrospective study including 64 eyes of 35 patients who underwent surgery with implantation of the AT LISA 909M multifocal toric IOL (Carl Zeiss Meditec) in 2 different ophthalmologic centers using different criteria for corneal incision size: sub-1.8 mm ... incision surgery [MICS] group) ... sion group). ... outc... Addi...

Toric intraocular lenses (IOLs) have been created to address the correction of pre-existing astigmatism by inducing the required toricity for compensating corneal astigmatism.[1,2] They are aimed at providing complete distance visual rehabilitation and are especially useful for some cases normally associated with high levels of corneal astigmatism, such as ectatic or post-keratoplasty corneas.[3,4] However, monofocal toric designs ... compensate for the loss of acco... alline lens ... intermedi- ... concept of ... o provide ... ul option ... gmatism.

Comparison of the Visual and Intraocular Optical Performance of a Refractive Multifocal IOL With Rotational Asymmetry and an Apodized Diffractive Multifocal IOL

Jorge L. Alió, MD, PhD; Ana B. Plaza-Puche, MSc; Jaime Javaloy, MD, PhD; María José Ayala, MD, PhD

ABSTRACT

PURPOSE: To compare the visual outcomes and intraocular optical quality obtained postoperatively in patients implanted with a rotationally asymmetric multifocal intraocular lens (IOL) and an apodized diffractive multifocal IOL.

METHODS: Seventy-four consecutive eyes of 40 cataract patients (age range: 36 to 73 years) were divided into two groups: one refractive group, 39 eyes implanted with a rotationally asymmetric multifocal IOL (Lentis Mplus LS-312 IOL, Oculentis GmbH); and diffractive group, 35 eyes implanted with an apodized diffractive multifocal IOL (TECNIS ZMB00, Abbott Medical Optics Inc.). ... [illegible]

The Lentis Mplus (Oculentis GmbH, Berlin, Germany) intraocular lens (IOL) is a refractive rotationally asymmetric multifocal IOL, which has been introduced in clinical practice and has shown excellent preliminary visual outcomes and low incidence of photic phenomena inducing minimal losses in contrast sensitivity.[1] The clinical outcomes of hybrid multifocal IOLs with near vision adds of +4.00 and +3.00 diopters (D) have been reported extensively elsewhere.[2]

Rotationally asymmetric multifocal optics may represent an advantage for visual performance, but thus far no comparative study with rotationally asymmetric diffractive optics has been reported. Apodized diffractive multifocal IOLs are the most commonly implanted multifocal IOL. Such lenses

Rotationally Asymmetric Multifocal IOL Implantation With and Without Capsular Tension Ring: Refractive and Visual Outcomes and Intraocular Optical Performance

Jorge L. Alió, MD, PhD; Ana B. Plaza-Puche, MSc; David P. Piñero, PhD

ABSTRACT

PURPOSE: To ascertain whether the refractive, visual, and intraocular optical quality outcomes of a rotationally asymmetric multifocal intraocular lens (IOL) are enhanced by the use of a capsular tension ring.

A new concept of intraocular multifocality has been recently developed and introduced in clinical practice: refractive rotational asymmetry, in which a ... fractive sector is used for near vision add. Our research has demonstrated that this type of intraoc... able to successfully restore uncorre...

ARTICLE

Optical analysis, reading performance, and quality-of-life evaluation after implantation of a diffractive multifocal intraocular lens

Jorge L. Alió, MD, PhD, Ana B. Plaza-Puche, MSc, David P. Piñero, PhD, Francisco Amparo, MD, Ramón Jiménez, MSc, Jose L. Rodriguez-Prats, MD, Jaime Javaloy, MD, Vanessa Pongo, MD

PURPOSE: To evaluate the reading performance, changes in quality of life, and optical performance after cataract surgery with multifocal diffractive intraocular lens (IOL) implantation.

SETTING: Vissum Corporation, Alicante, Spain.

DESIGN: Prospective case series.

METHODS: Patients with bilateral cataract had implantation of Acri.LISA 366D multifocal IOLs. Visual acuity and contrast sensitivity outcomes were evaluated during a 6-month follow-up. Other parameters evaluated included reading performance (Salzburg Reading Desk), a 25-item quality-of-life questionnaire (National Eye Institute Visual Functioning Questionnaire-25 [NEI VFQ-25] and appendix NEI VFQ-39), and ocular optical performance (ocular aberrometry and modulation transfer function).

RESULTS: The study included 48 eyes (24 patients) ranging in age from 47 to 77 years. The mean uncorrected distance visual acuity (logMAR) improved significantly 1 month postoperatively ($P<.01$), with no significant changes afterward (6 months, $P\geq.06$). The mean reading acuity without correction improved significantly from 0.88 logRAD ± 0.20 (SD) to 0.16 ± 0.08 logRAD 1 month after surgery ($P<.01$). However, it was worse by the end of the follow-up (6 months, $P=.04$). During the follow-up, no significant changes were found in the mean reading speed without near correction (6 months, $P=.50$). Contrast sensitivity improved significantly at all spatial frequencies under photopic and scotopic conditions after surgery (3 months, $P=.03$). The ... related to reading ability also improved significantly (3 months, $P=.02$). The ... [illegible] ... IOL significantly improved reading performance ... [illegible]

Visual outcomes with a single-optic accommodating intraocular lens and a low-addition-power rotational asymmetric multifocal intraocular lens

ARTICLE

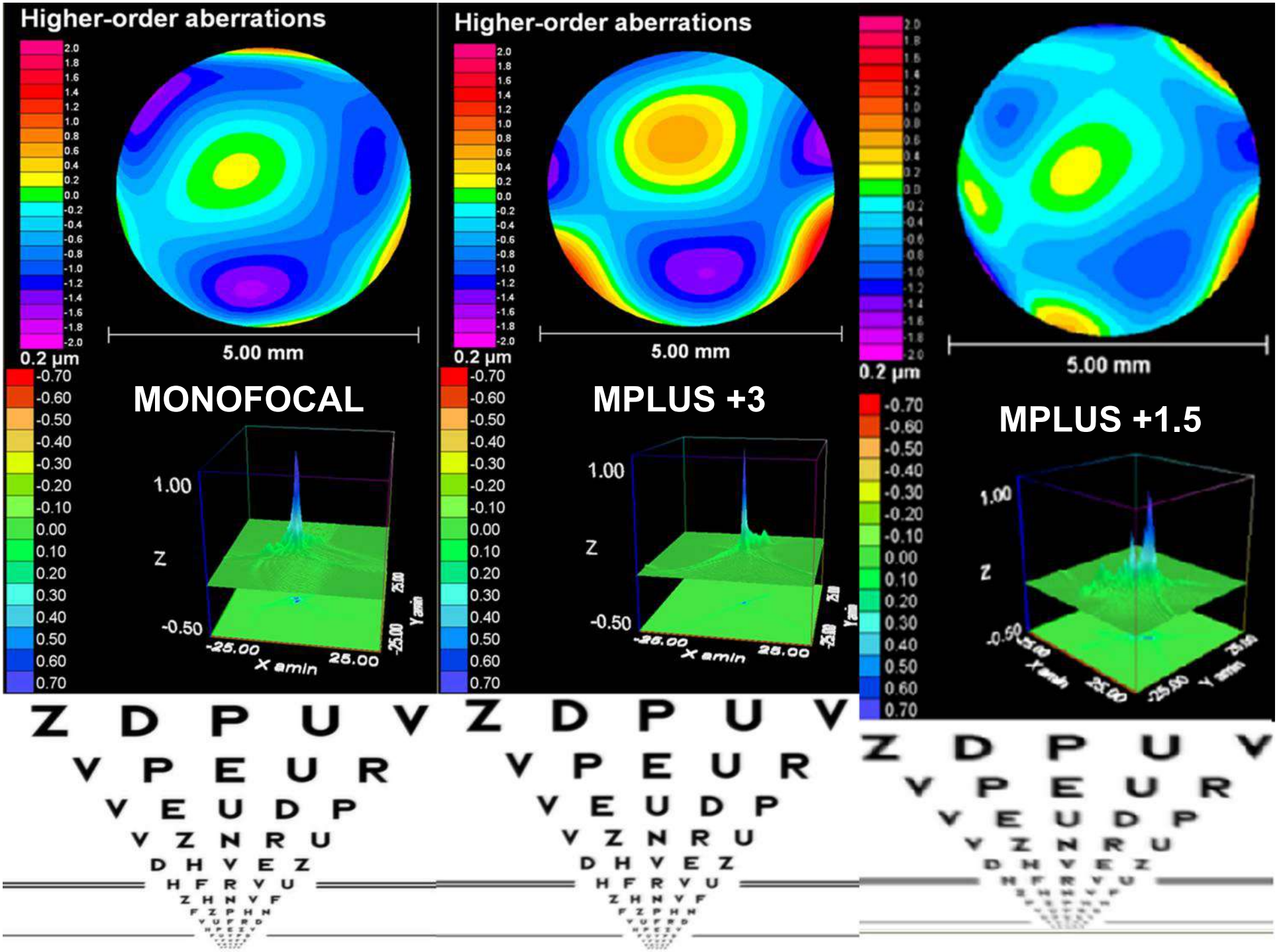
Jorge L. Alió, MD, PhD, Ana B. Plaza-Puche, MSc, Raúl Montalbán, MSc, Jaime Javaloy, MD, PhD

PURPOSE: To compare the visual outcomes and intraocular optical quality in patients with a low-addition (add) power multifocal refractive intraocular lens (IOL) with rotational asymmetry and a single-optic accommodating IOL.

SETTING: Vissum Instituto Oftalmológico de Alicante, Miguel Hérnandez University, Alicante, Spain.

DESIGN: Prospective comparative nonrandomized consecutive case series.

METHODS: Consecutive cataract patients had implantation of a low-add-power refractive multifocal IOL with rotational asymmetry (Lentis-Mplus LS-312 MF15) (multifocal group) or a single-optic ... [illegible]


Higher-order aberrations
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
5.00 mm
0.2 µm
-0.70
-0.60
-0.50
-0.40
-0.30
-0.20
-0.10
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
MONOFOCAL
1.00
Z
-0.50
-25.00
X amin
25.00
Y amin
Higher-order aberrations
5.00 mm
MPLUS +3
Higher-order aberrations
5.00 mm
MPLUS +1.5
Z D P U V
V P E U R
V E U D P
V Z N R U
D H V E Z
H F R V U
Z H N V F
F Z P H N
Z D P U V
V P E U R
V E U D P
V Z N R U
D H V E Z
H F R V U
Z H N V F
F Z P H N
Z D P U V
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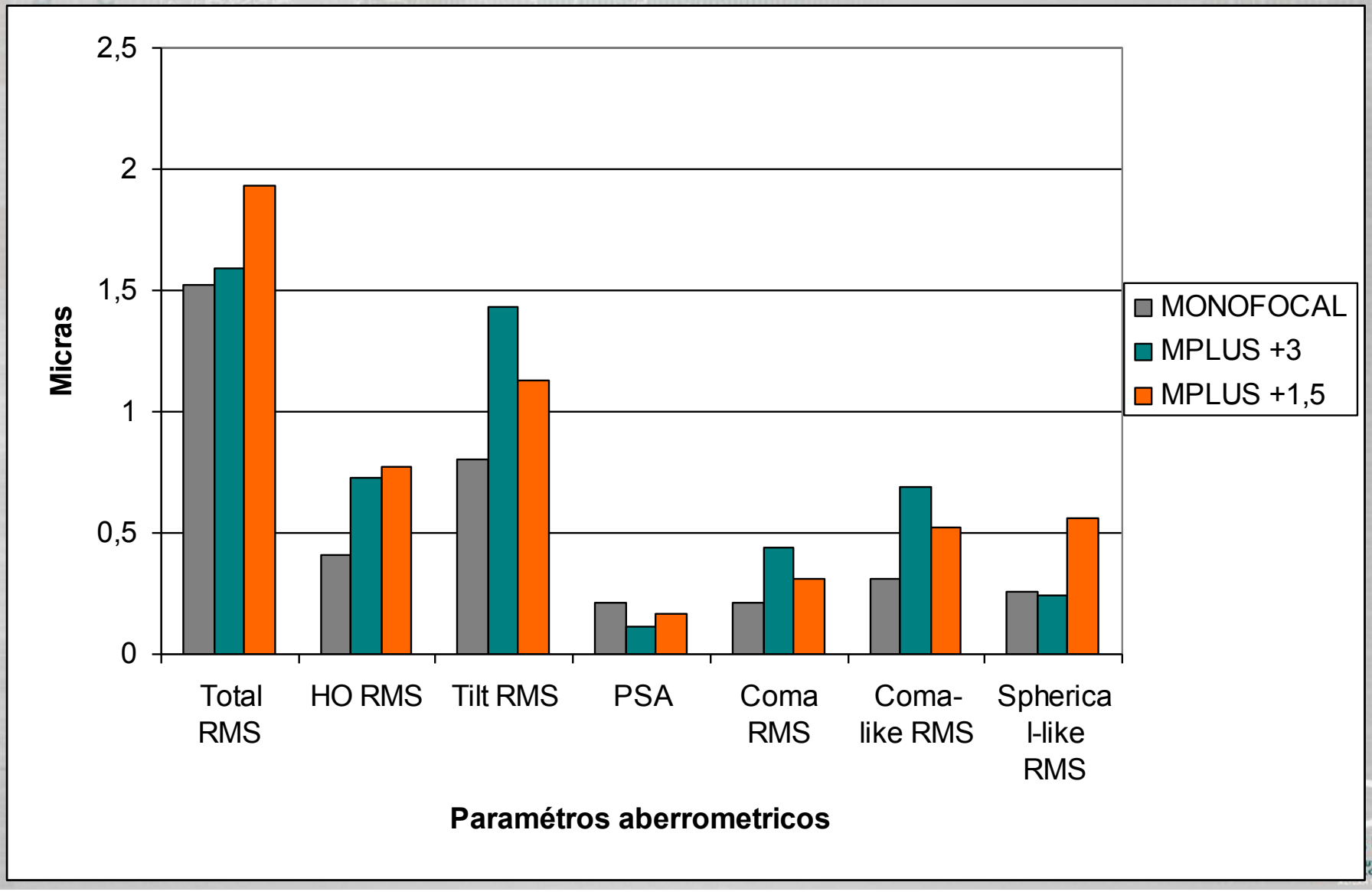
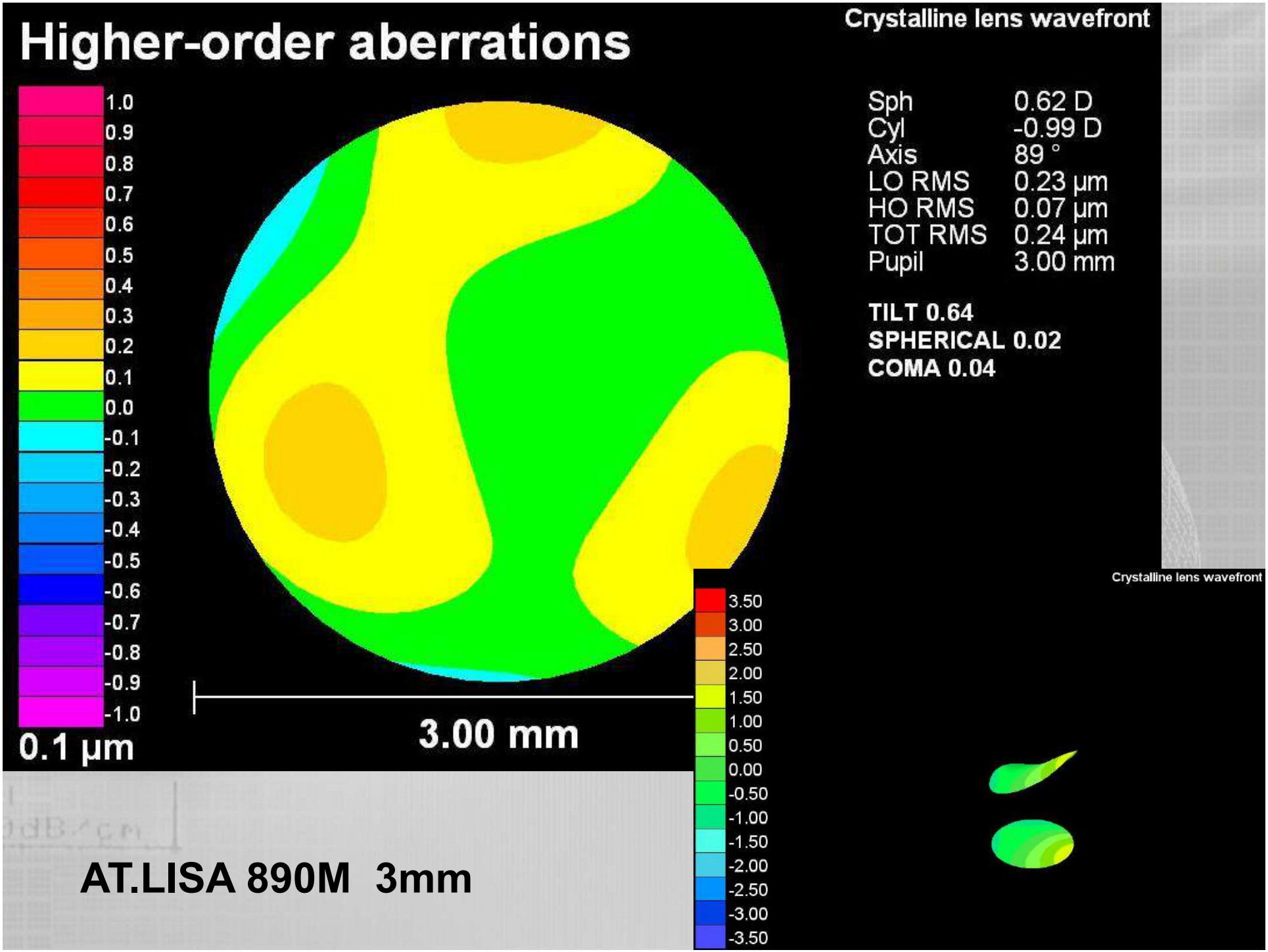
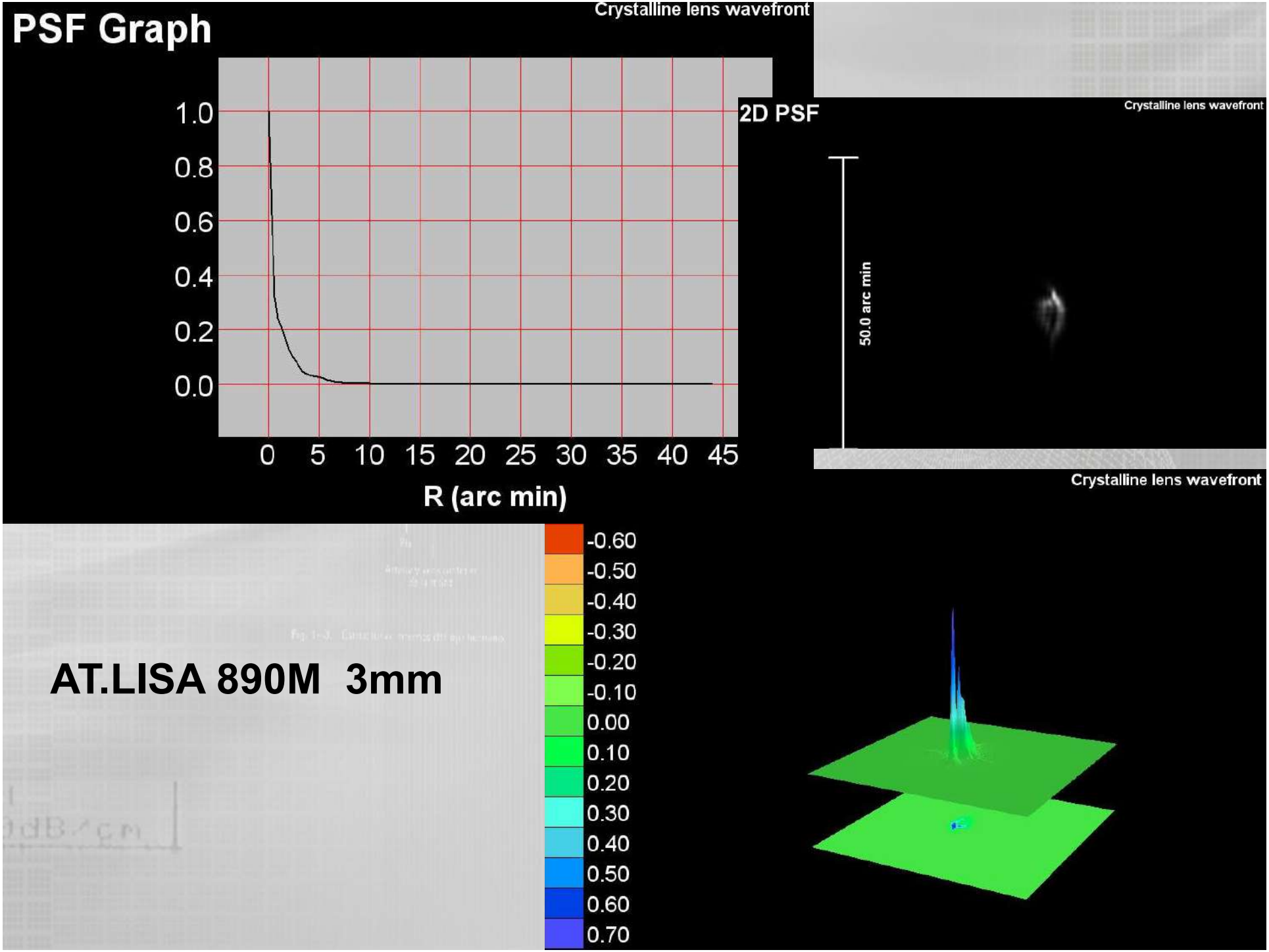
V E U D P
V Z N R U
D H V E Z
H F R V U

“ In Vivo” INTRAOCULAR OPTICAL PERFORMANCE



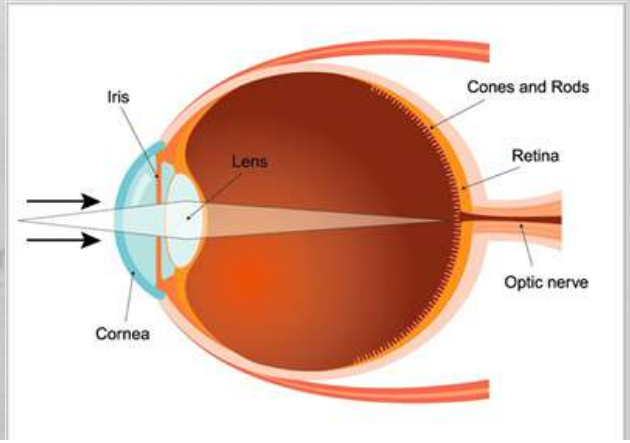

Higher-order aberrations
Crystalline lens wavefront
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0
0.1 µm
3.00 mm
Sph 0.62 D
Cyl -0.99 D
Axis 89 °
LO RMS 0.23 µm
HO RMS 0.07 µm
TOT RMS 0.24 µm
Pupil 3.00 mm
TILT 0.64
SPHERICAL 0.02
COMA 0.04
Crystalline lens wavefront
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
-3.50
AT.LISA 890M 3mm

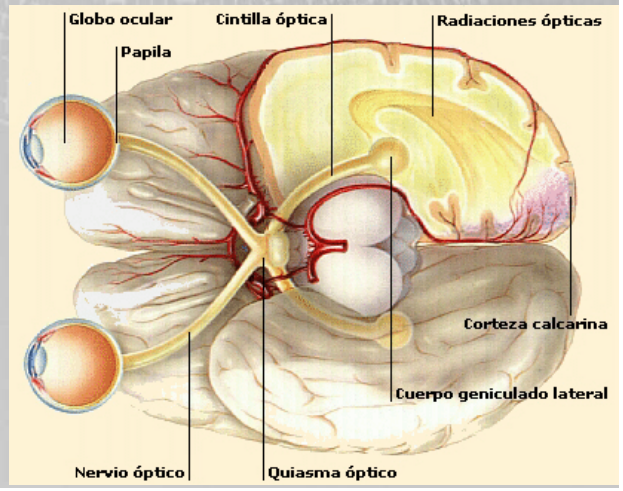

PSF Graph
1.0
0.8
0.6
0.4
0.2
0.0
0 5 10 15 20 25 30 35 40 45
R (arc min)
Crystalline lens wavefront
2D PSF
Crystalline lens wavefront
50.0 arc min
Crystalline lens wavefront
AT.LISA 890M 3mm
-0.60
-0.50
-0.40
-0.30
-0.20
-0.10
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70

OPTICAL PERFORMANCE IS NOT VISUAL PERFORMANCE…

- **Optical quality and retinal quality** are essential elements of the performance of any IOL

- But **visual performance** involves **neuroprocessing** and is a cortical perception….

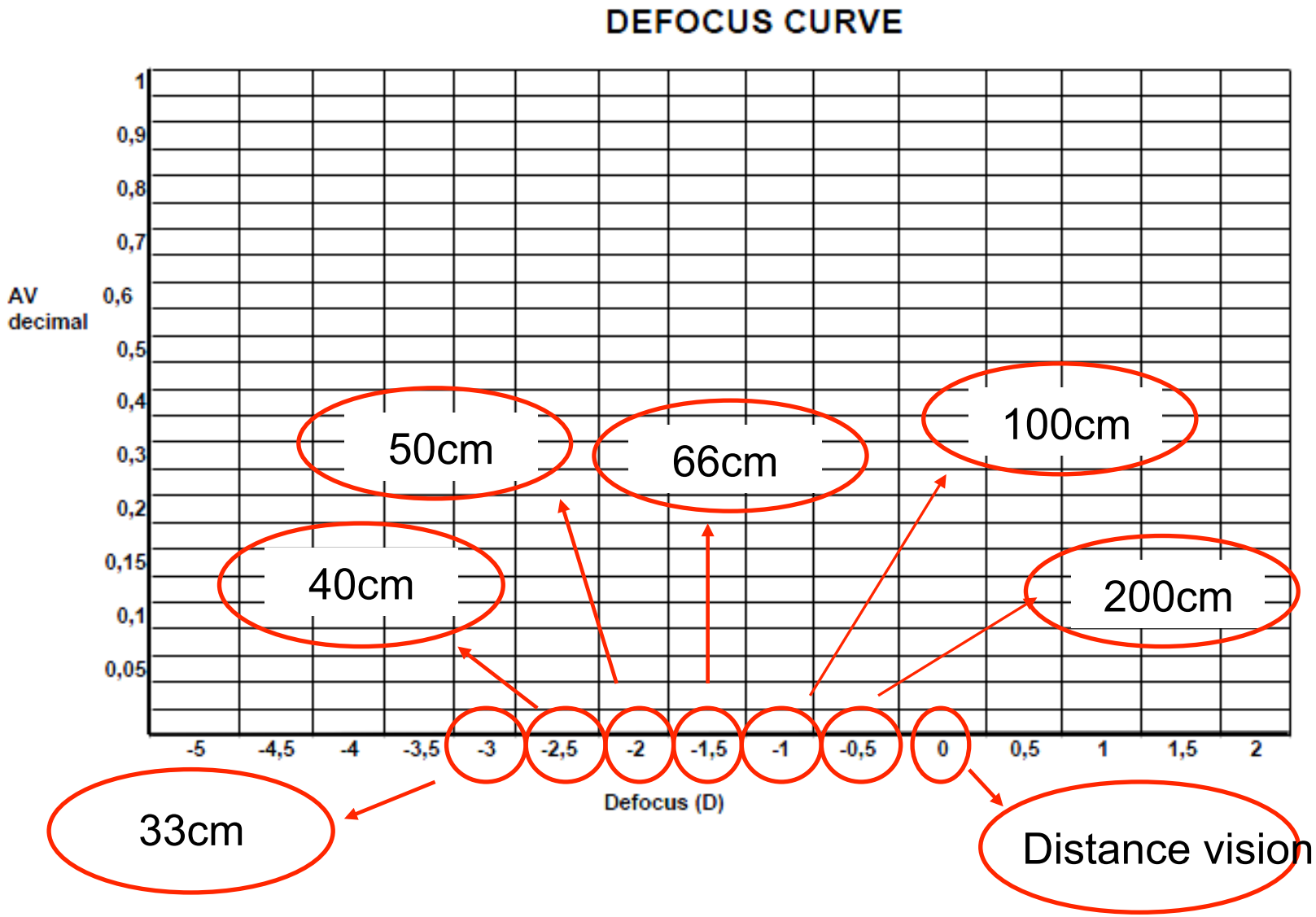




VISUAL OUTCOME SUCCESS THAT SHOULD BE OFFERED BY THE LENS

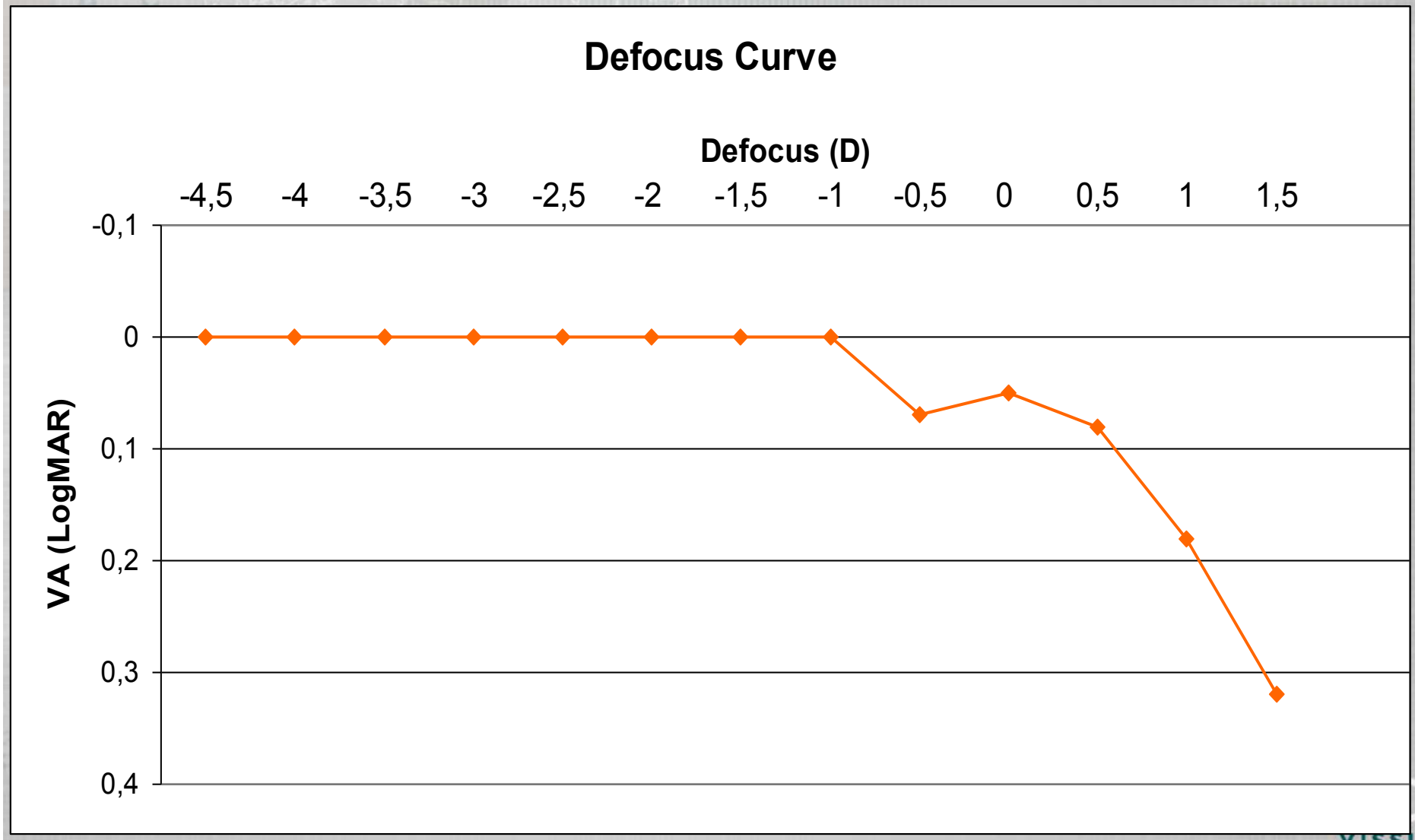
- **Good for FAR**: FAR FOCUS must be the dominant (20/20, 0.6 dec)
- **Adequate intermediate:** Computer**,** office & domestic tasks (Radner 20/30; 0.7 dec)
- **Adequate for NEAR**: Functional near vision (J2, Radner 20/25 0.8 dec)

DEFOCUS CURVE STUDY



DEFOCUS CURVE

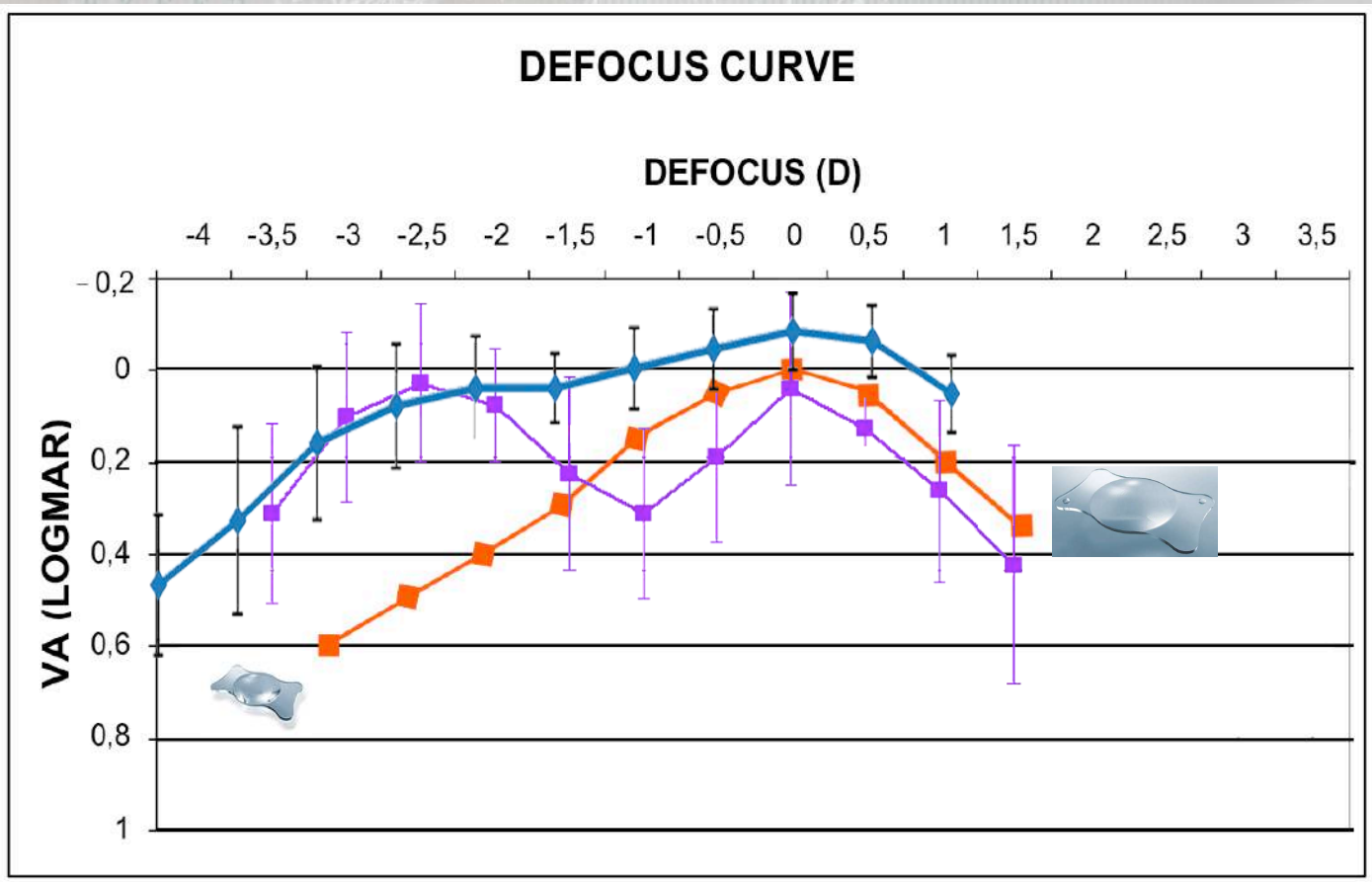
Emmetropic Defocus curve of a young 30 yr old person




UNIVERSITAS Miguel Hernández
Postoperative bilateral reading performance with 4 intraocular lens models: Six-month results
ARTICLE
Rotationally Asymmetric Multifocal IOL Implantation With and Without Capsular Tension Ring: Refractive and Visual Outcomes and Intraocular Optical Performance
Comparative analysis of the clinical outcomes with 2 multifocal intraocular lenses with rotational asymmetry
Comparison of a New Refractive Multifocal Intraocular Lens with an Inferior Segmental Near Add and a Diffractive Multifocal Intraocular Lens
Visual outcomes with a single-optic accommodating intraocular lens and a low-addition-power asymmetric multifocal intraocular lens
Near visual outcomes with single-optic and dual-optic accommodating intraocular lenses
VISSUM INSTITUTO OFTALMOLÓGICO ALICANTE

DEFOCUS CURVE

MONOFOCAL ACRI.SMART48S vs AT LISA BIFOCAL vs AT LISA TRIFOCAL



(ZEISS monofocal)

MONOFOCAL SPHERICAL IOL Acri.Smart 48S

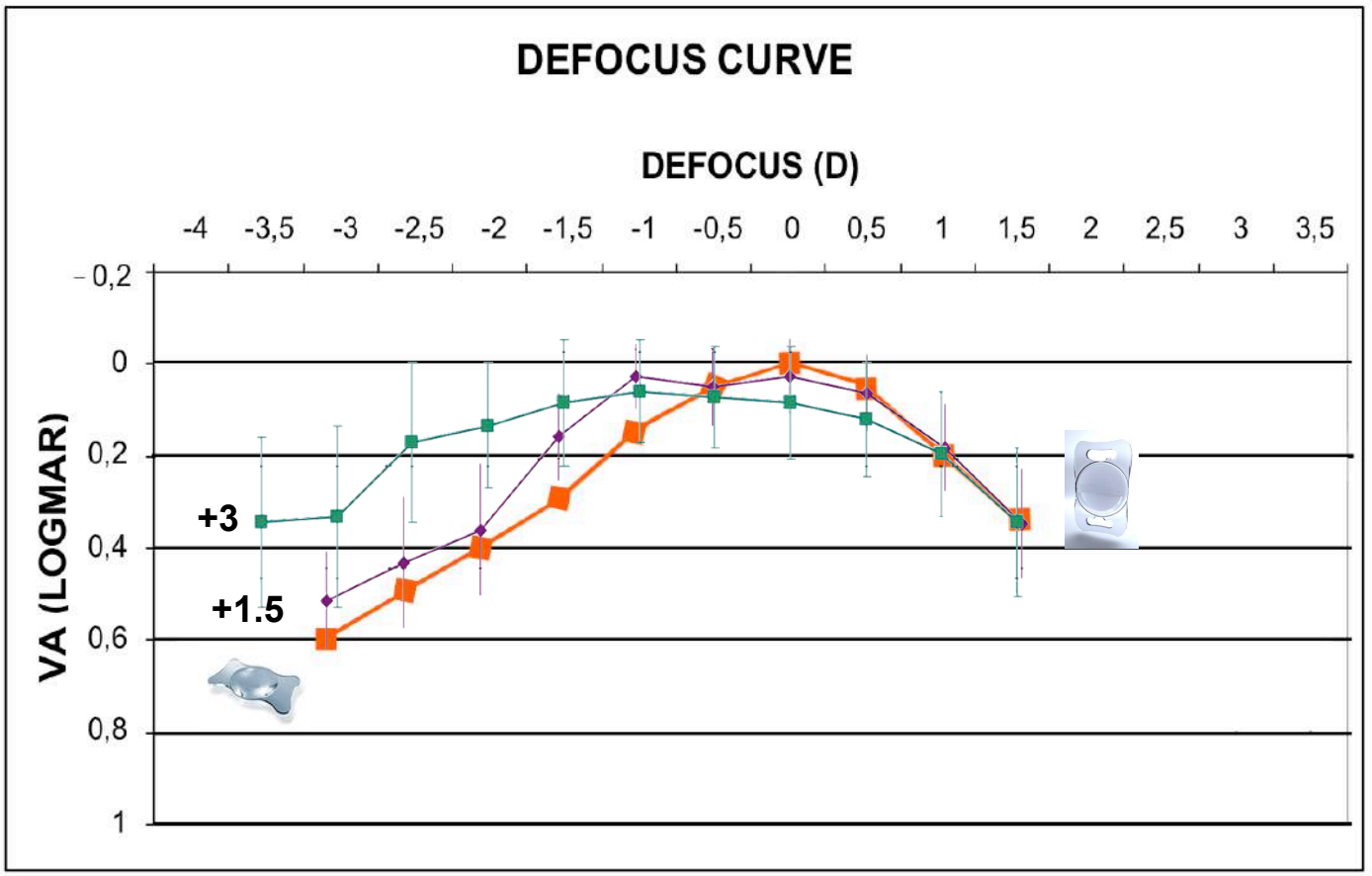
AT LISA BIFOCAL 809M

AT LISA TRIFOCAL 839MP

(ZEISS bifocal/ trifocal)

DEFOCUS CURVE

MONOFOCAL ACRI.SMART48S vs MPLUS +1.5/+3D



(ZEISS)

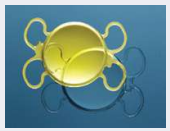
MONOFOCAL SPHERICAL IOL
Acri.Smart 48S

MPLUS +1.5

MPLUS +3

(OCULENTIS)

MULTIFOCAL IOL´S
DIFFRACTIVE TECHNOLOGY (I)

		INCISION SIZE	ASPHERICITY	NEAR ADD	PUPIL DEPENDENCE % OF LIGHT N/F	CLINICAL STUDIES
AT-LISA Bi/Tri (ZEISS)		1.8 mm	Neutral	+3.75/ Trif +1.75	Dependent 35/65% Tri 50-20-30	Published
FINE VISION (PhysIOL)		1.8 mm	Neutral	+3.5/trif + 1,75	Dependent 35/17/48%	Published
RESTOR (ALCON)		2.2 mm	Neutral/ negative asphericity +2.5	+4/+3/+2.5	Dependent 50/50%t	Published
SEELENS MF (HANITA)		1.8 mm	Aspheric neutral Bi convex	+3	Dependent 65/35%	Published
Tecnis one (AMO)		2.75 mm	Negative asphericity	+4	Independent 50/50% Increased DOF	Published

MULTIFOCAL IOL´S
REFRACTIVE TECHNOLOGY (I)

		INCISION SIZE	ASPHERICITY	NEAR ADD	PUPIL DEPENDENCE % OF LIGHT N/F	CLINICAL STUDIES
MPLUS (OCULENTIS)		2 mm	Neutral	+3/ +1´5	Independent between 2 and 6 mmt 80/20t	Published
RAYNER M-flex		2.75mm	Neutral	+4/+3	Pupil dependent	Published

Essentials in Ophthalmology
Series Editor: Arun D. Singh

Jorge L. Alió · Joseph Pikkel *Editors*

Multifocal Intraocular Lenses

The Art and the Practice

This book provides the practising ophthalmologist and surgeon with up-to-date information on the use of multifocal intraocular lenses to eliminate pseudophakic presbyopia. Guidance is provided on types and models of intraocular lens, indications, selection of patients, implantation, neuroadaptation, and complications and their avoidance. A key goal is to enable the practitioner to select the best lens for the individual patient, taking into account special circumstances. In addition, the results achieved to date with different lenses are analyzed and advice is given on the management of expectations. The authors are acknowledged international experts who draw upon their own experience and the peer-reviewed literature to provide the practitioner with cutting-edge information and evidence-based guidance.

Ophthalmology
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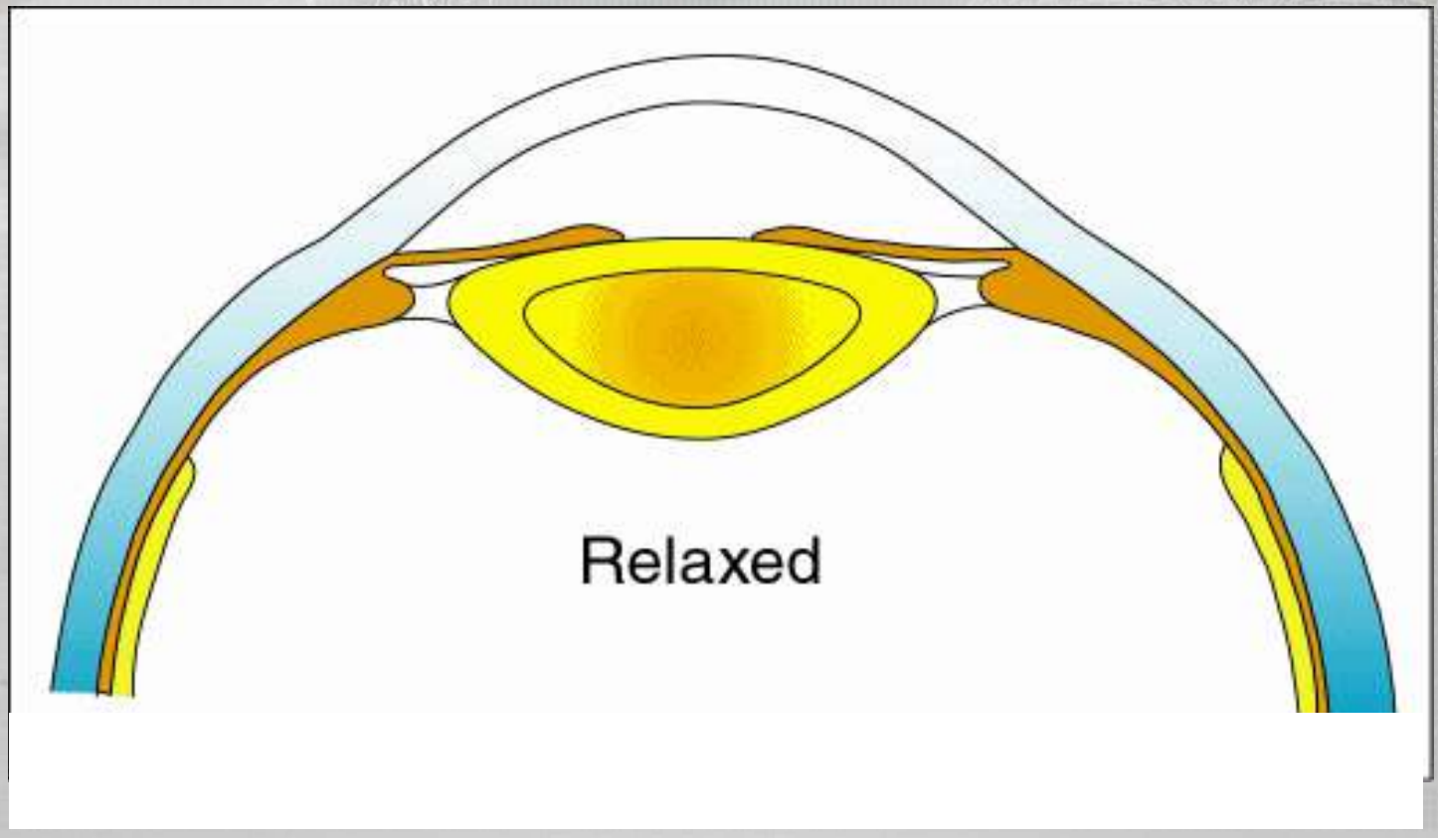
Multifocal Intraocular Lenses

The Art and the Practice

Springer

WHAT IS ACCOMMODATION ?

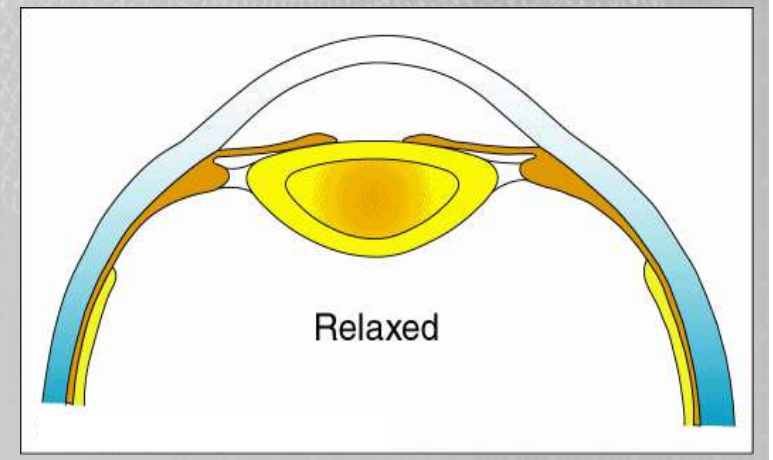
- Progressive change in the power of the lens / IOL related to active ciliairy body action



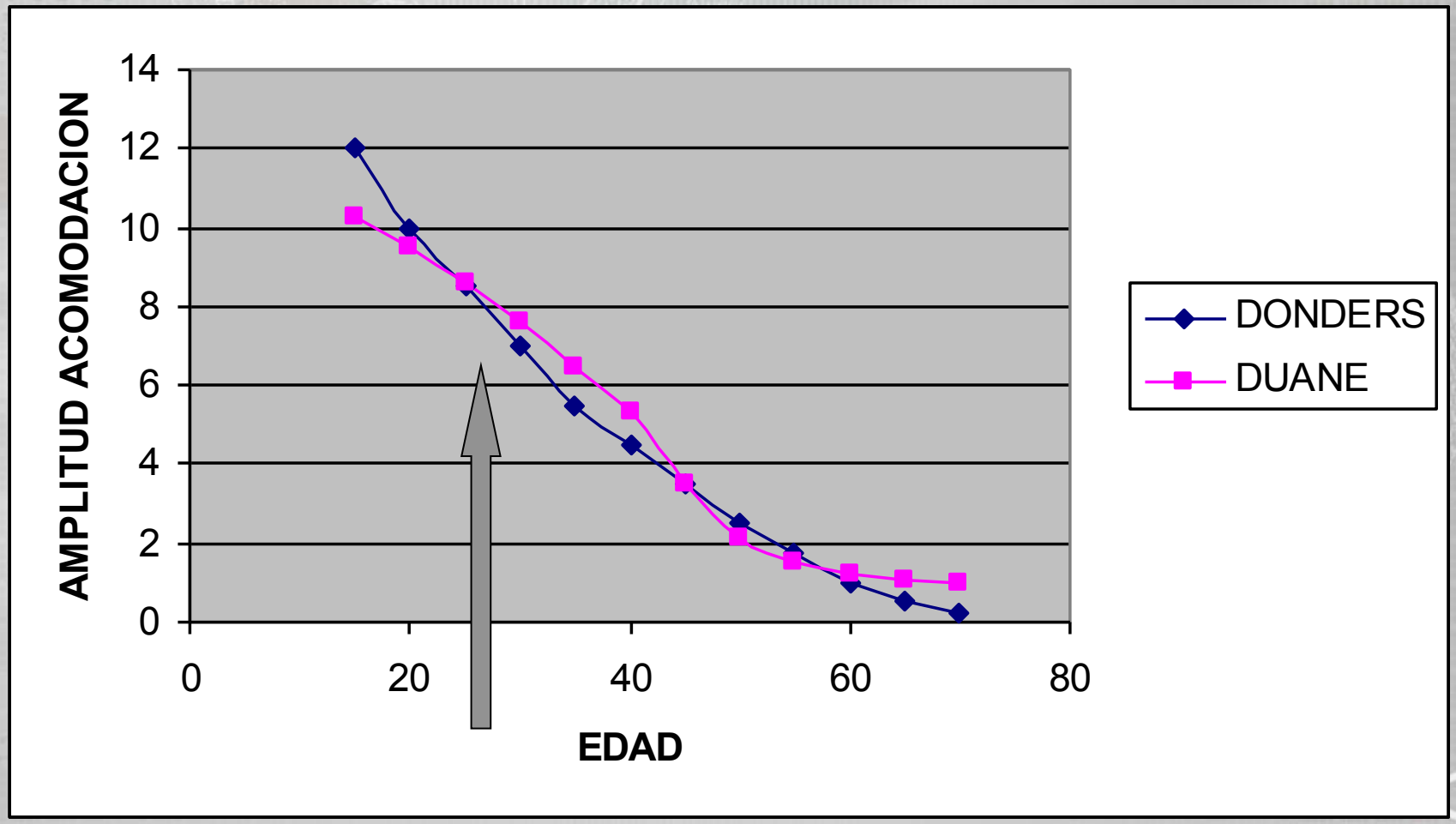
ACCOMMODATION

Our main understanding, widely accepted and proved of how accommodation occurs stems from the early work of **Hermann von Helmholtz** (Handbuch der Physiologischen Optik. 1856, vol. 1)

He showed that accommodation occurs when the cilliary muscle contracts releasing the zonular tension to the equatorial edge of the lens.



ACCOMMODATION & AGE (DUANE/DONDERS)



ACCOMMODATION & AGE (DUANE/DONDERS)

AGE	DONDERS	DUANE
15	12	10,3
20	10	9,5
25	**8,5**	**8,6**
30	**7**	**7,6**
35	5,5	6,5
40	**4,5**	**5,3**

AGE	DONDERS	DUANE
45	3,5	3,5
50	**2,5**	**2,1**
55	1,75	1,5
60	**1**	**1,2**
65	0,5	1,1
70	0,25	1

TO RECOVER CONFORTABLE NEAR VISION INDEPENDENCE…

No system is capable to function at 100% capacity for long time. Our assumption is that using only 50% of the accommodating potential will enable comfort and prolong function of the human accommodating system:

optics

1 Diopter for fine adjustment of the far plane

+ 3 Diopters for near adjustment

4 Diopters

x2 (avoiding fatigue) =

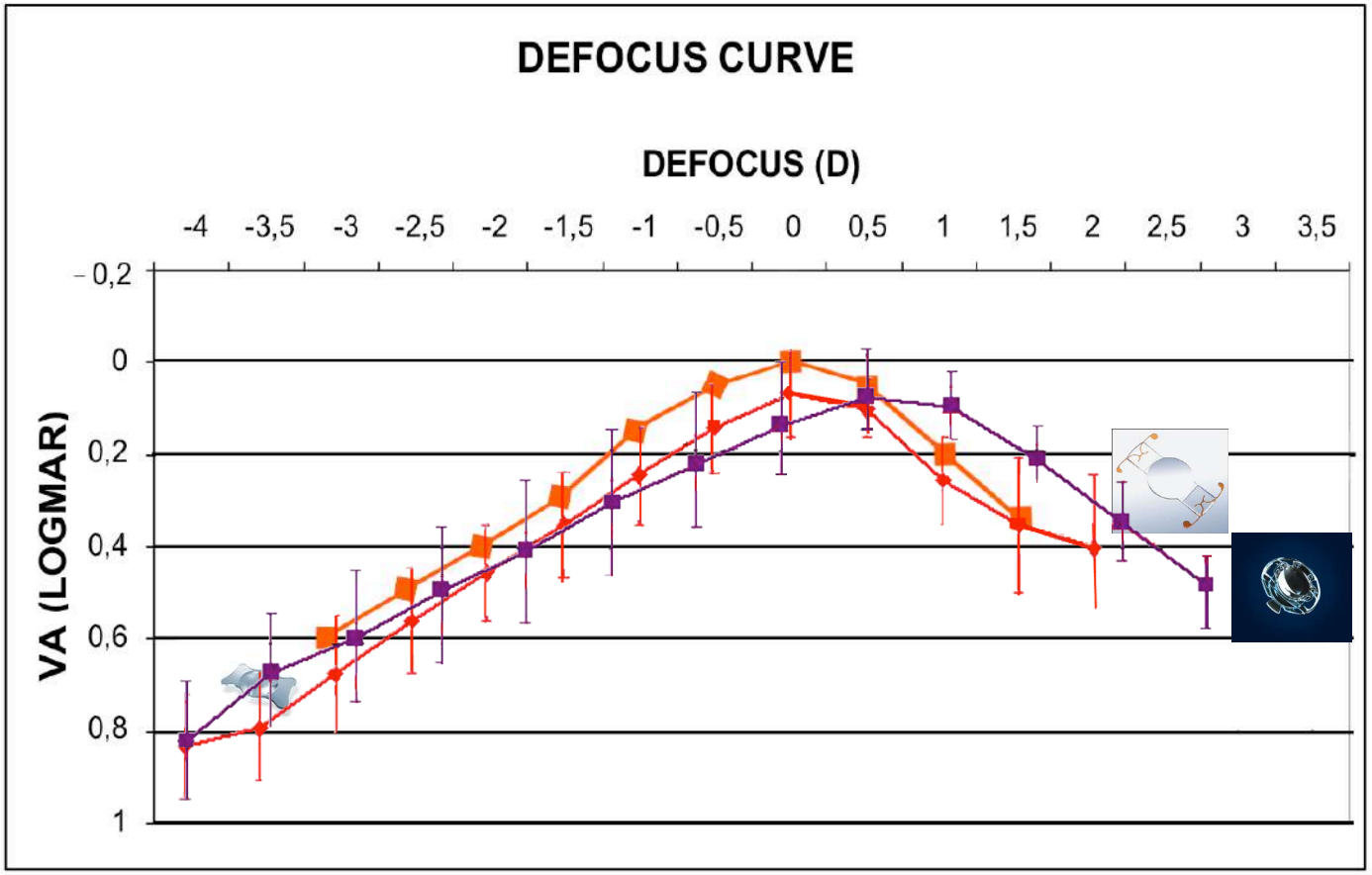
physiology

= 8 diopters

Comfort, speed of rending

“POTENTIALLY” ACCOMMODATING IOLs

MONOFOCAL ACRI.SMART48S vs CRYSTALENS vs SYNCHRONY



(ZEISS)

MONOFOCAL SPHERICAL IOL
Acri.Smart 48S

CRYSTALENS HD

SYNCHRONY

(BAUSCH & LOMB)

(VISIOGEN)

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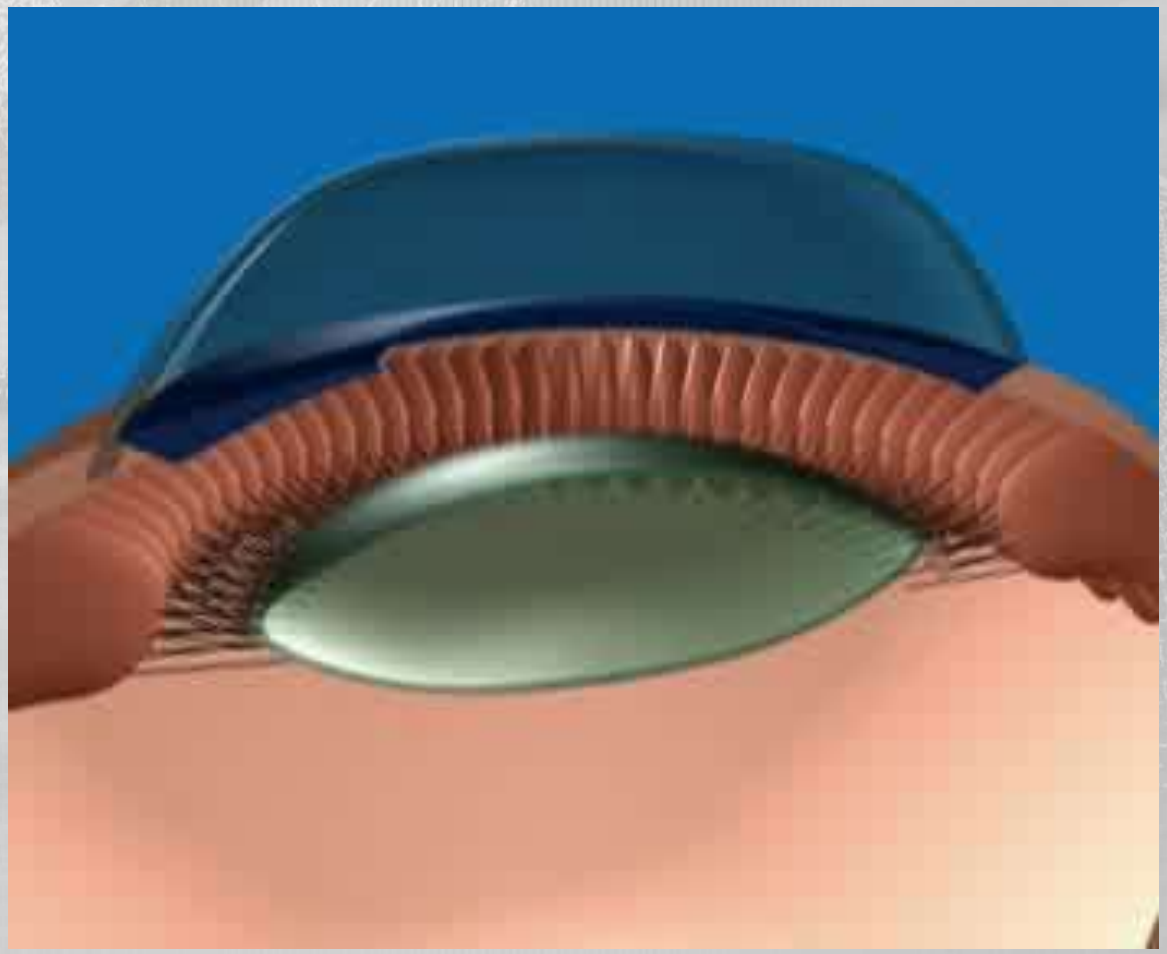
NuLens concept in accommodating IOL form

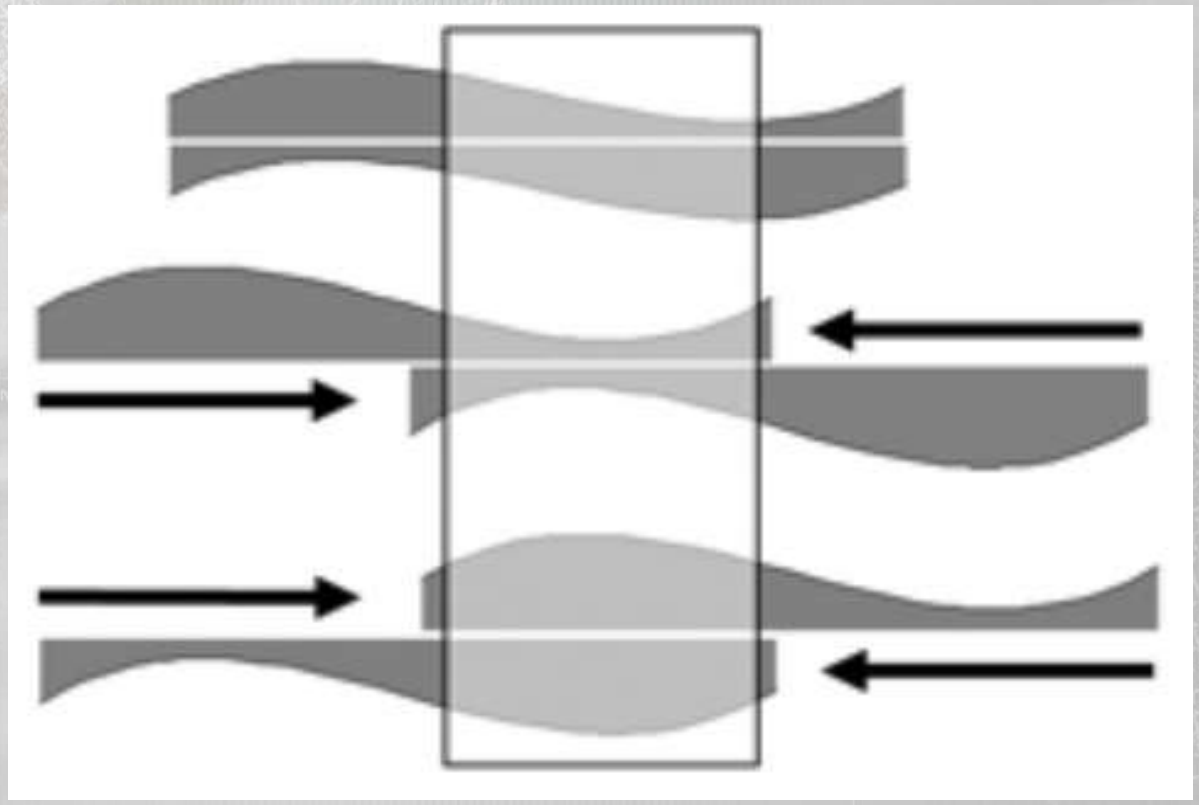


ACCOMMODATION ACHIEVED BY NEW SULCUS SUPPORTED IOL: THE AKKOLENS LUMINA

Jorge L. Alio MD PhD,
Alexander Angelov MD
Javor Angelov Msc
Aleksey Simonov PhD
Michiel Rombach PhD

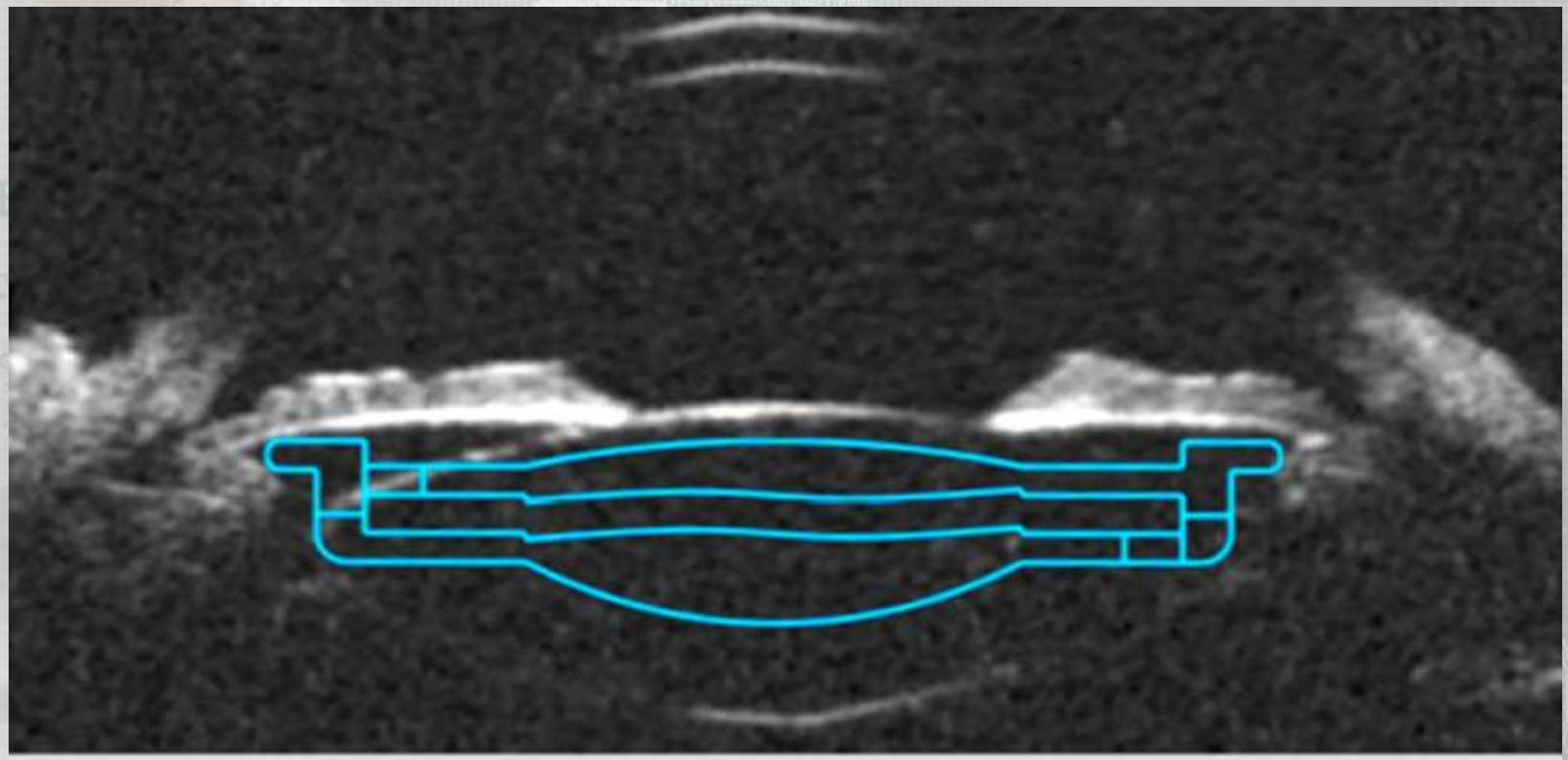
Vissum Corporacion Oftalmologica, Alicante, Spain
Resbiomed-Vissum Sofia Eye Clinic, Sofia, Bulgaria
AkkoLens International, Breda, The Netherlands

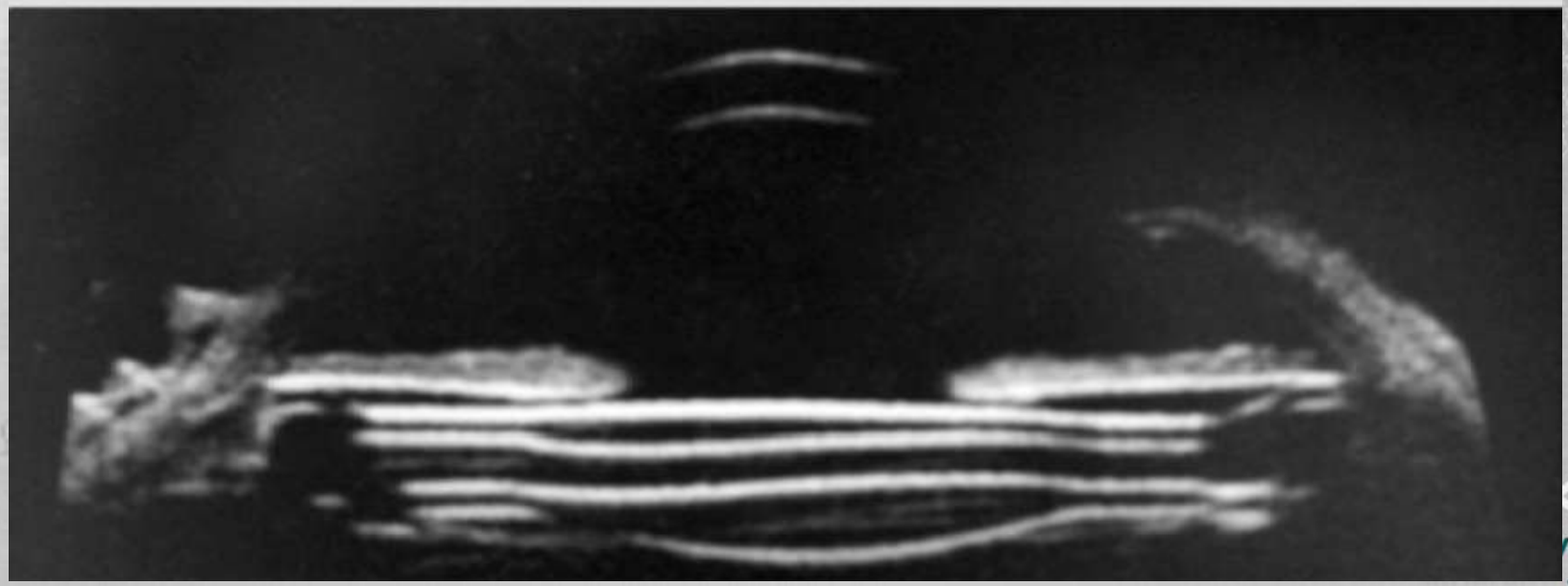
FUNDAMENTALS OF THE THEORY OF THE *LUMINA*



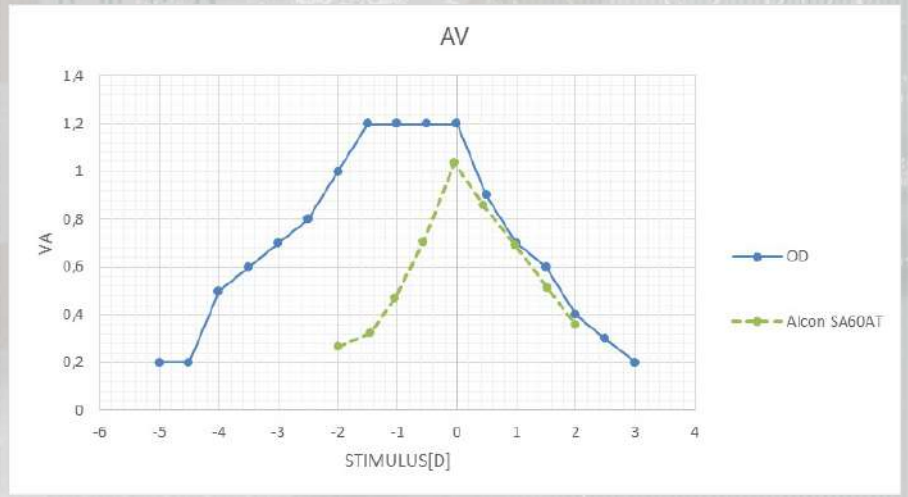
Two element varifocal lens which changes its focal

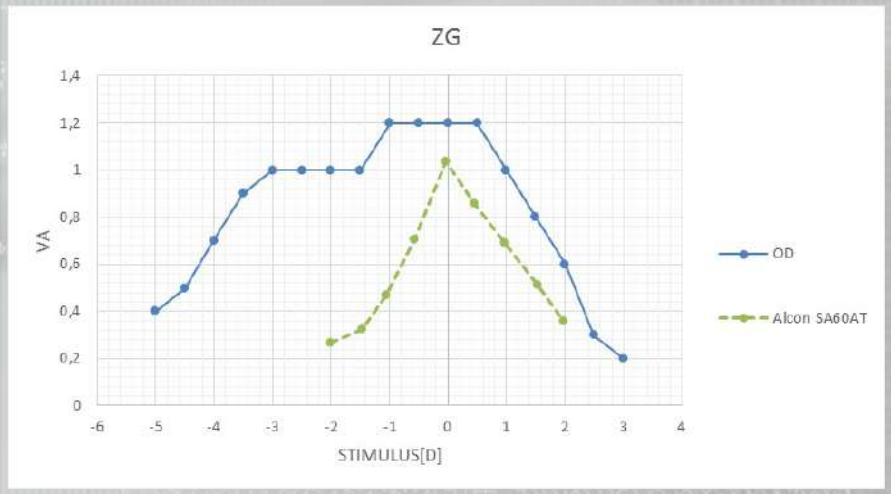
L.W. Alvarez, "Two-element variable-power spherical lens" U.S. Patent 3,305,294 (February 2, 1967)

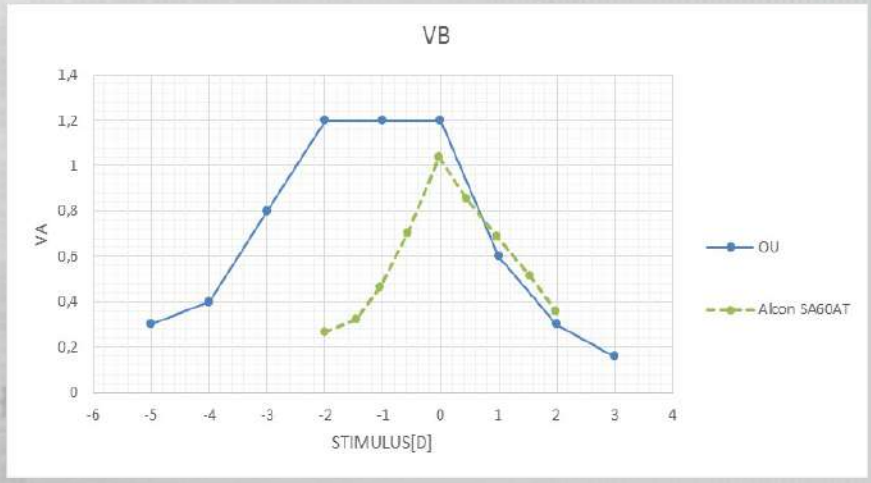


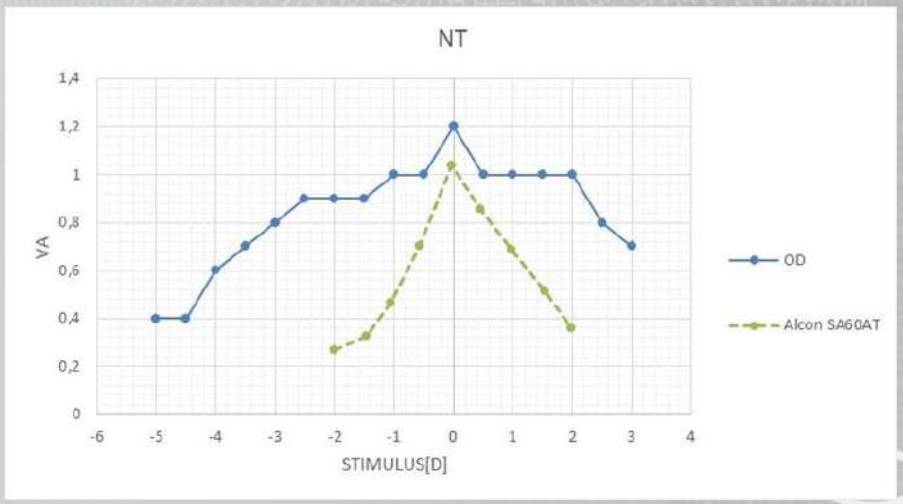


TYPICAL DEFOCUS CURVES AT ~6 MONTHS









Clinical data of the 1st patient reaching 1 year follow up (V.B., 72 years)

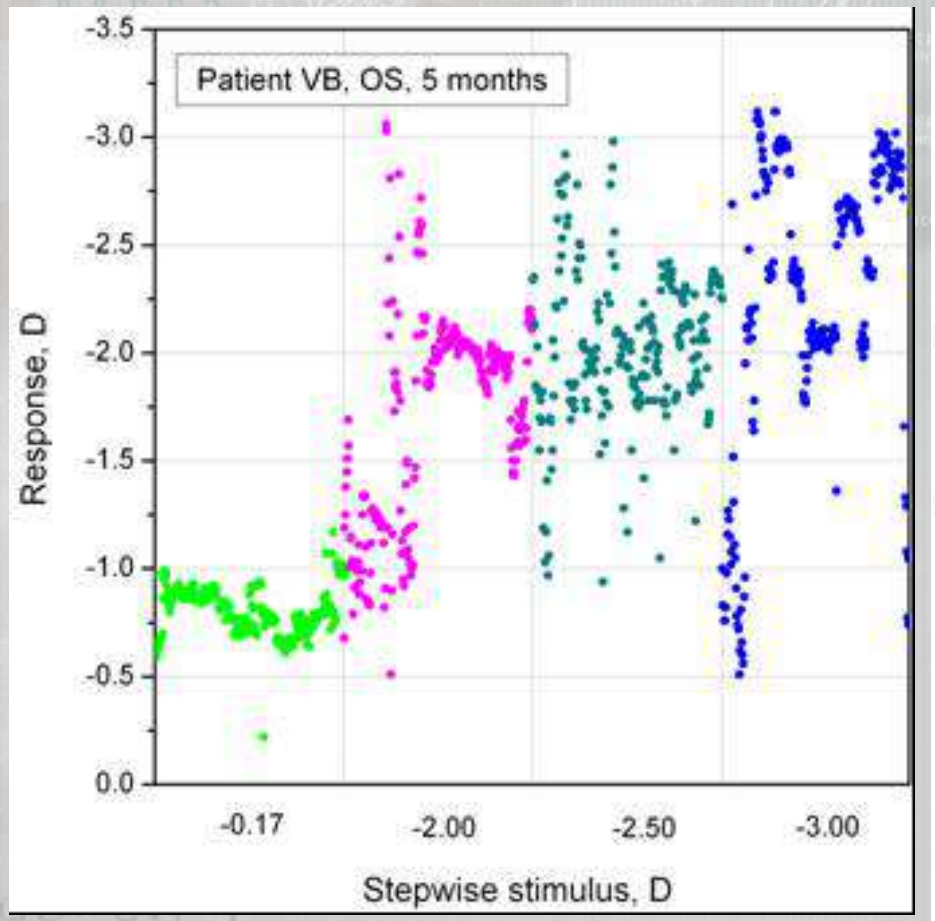
Clinical data of the 1st patient reaching 1 year follow up (Vlayka Bachvarova, 72 years)

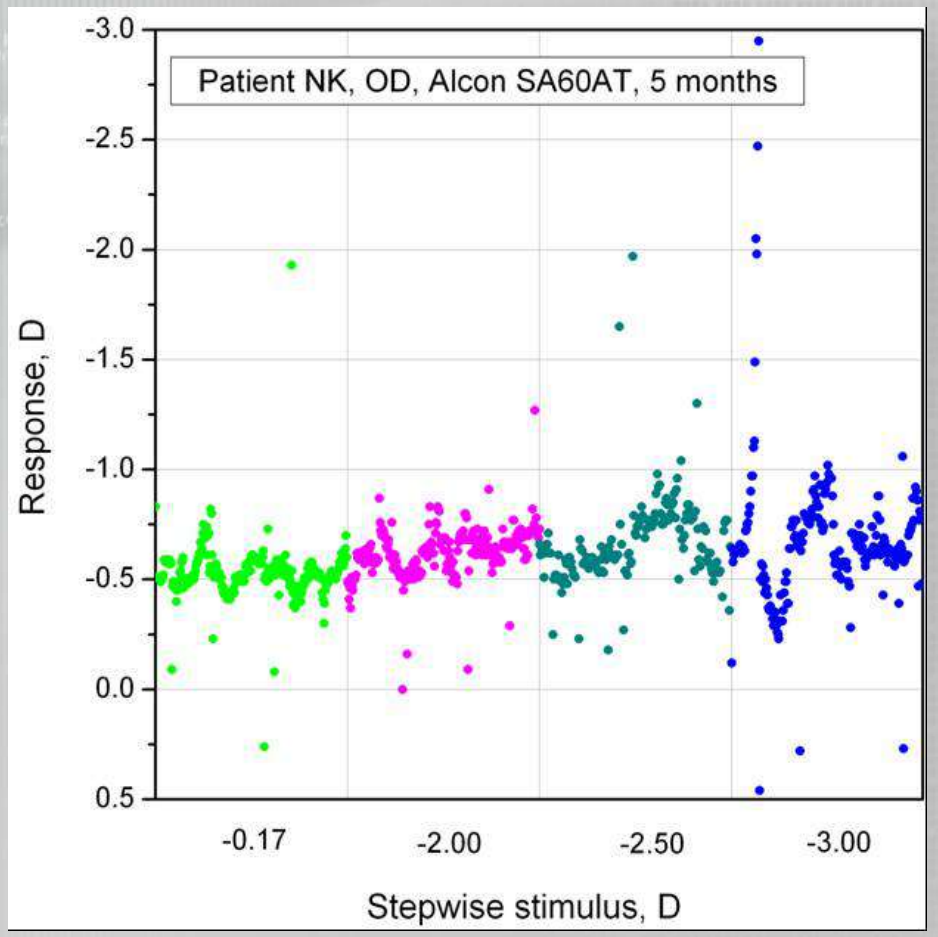
Lens type	Akko Lens
IOP	12,1
Sphere, D	0,75
Cylinder, D	-1,5
Angle, deg	83
Device	WAM
Eye	OS
-5	0,1
-4,5	0,2
-4	0,4
-3,5	0,7
-3	0,7
-2,5	0,8
-2	0,9
-1,5	1
-1	1
-0,5	1,2
0	1,2
0,5	0,8
1	0,6
1,5	0,4
2	0,2
2,5	0,16
3	0,1

Lens type	Akko Lens
Date of visit	12/12/13

UCVA Distance	1
BCVA Distance	**1,2**
UCVA near	1
BCVA near	1
DCVA near	**1**

Objective data
WAM study - *Lumina* lens vs monofocal





FINAL CONCLUSION

- Pseudo-accommodation approaches are the only methods available today to improve near vision performance in Presbyopia but their results are incomplete or artificial
- The promised land of ***real*** restoration of accommodation is now appearing in our horizon

- The authors have no proprietary interest in any of the materials or methods described.

This study has been supported in part by a grant of the Spanish Ministry of Health, Instituto Carlos III, Red Temática de Investigación en Oftalmología, Subproyecto de Cirugia Refractiva y Calidad Visual (C03/13)

Red temática de Investigación Cooperativa en oftalmología

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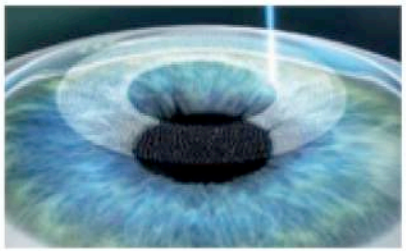
- *Good Clinical Practice (GCP) Course*
- *Guidelines and Standard Protocols*
- *Basic Research Methodology*
- *Course Final Project (under supervision of international tutor)*
- **With the collaboration of an international panel of *experts***



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Alicante, Spain

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- **CLIVE PECKARD** (Warrington Cheshire, UK)

- **CHARLES KELMAN**

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De la Comunidad Valenciana

GRACIAS !!

Jorge L. Alió

Catedratico de Oftalmologia

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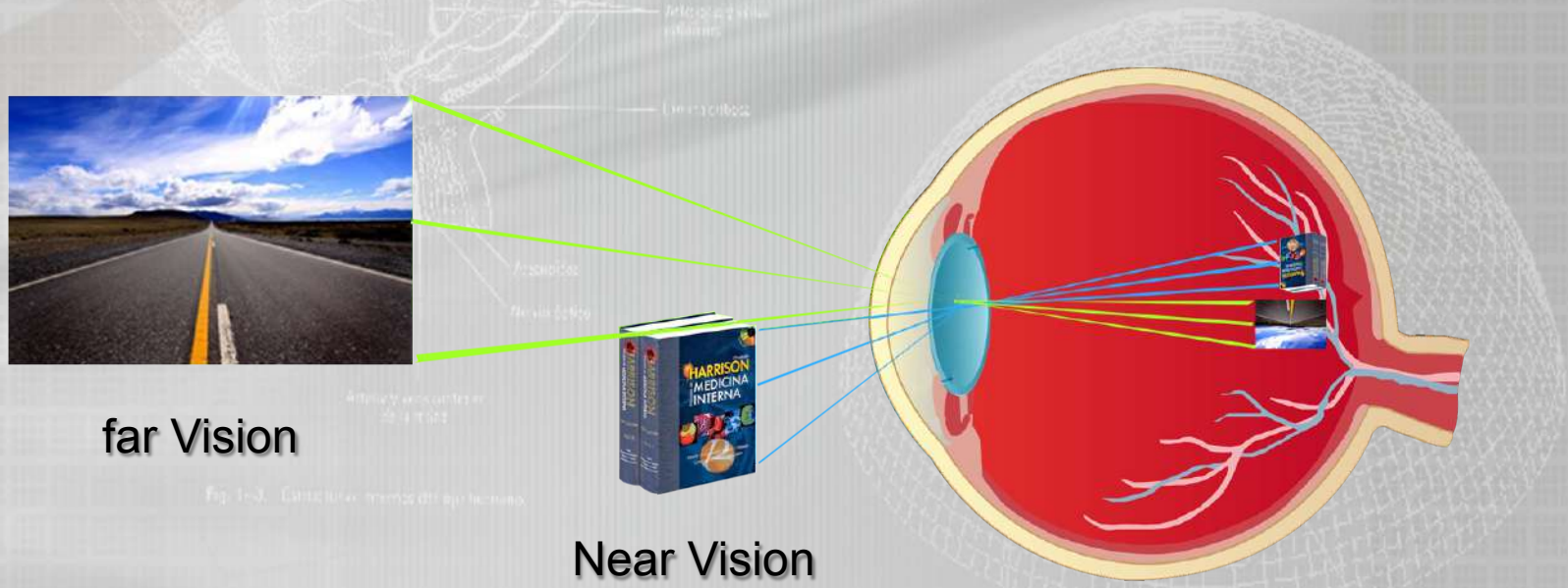
UNIVERSIDAD MIGUEL HERNÁNDEZ

Alicante

Multifocal intraocular lens

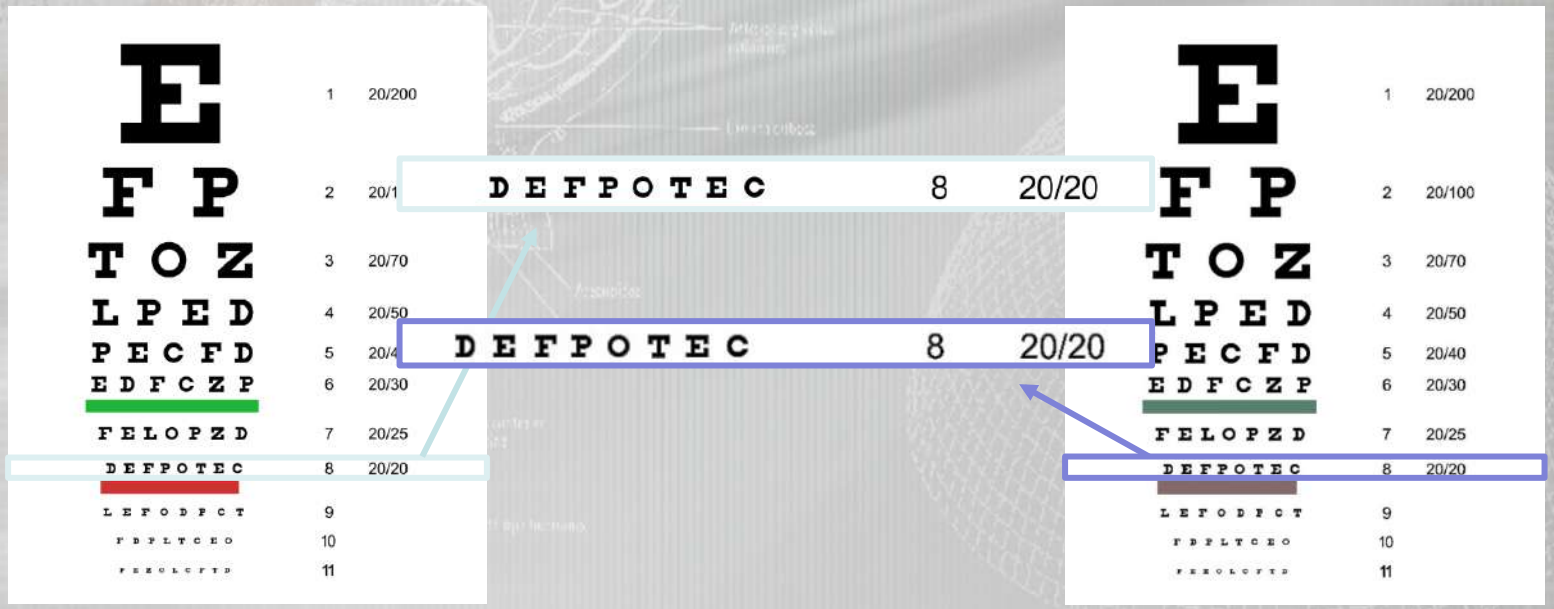


far Vision

Near Vision

Dificulties in evaluation of multifocal intraocular lens

image quantity Does not mean image quality

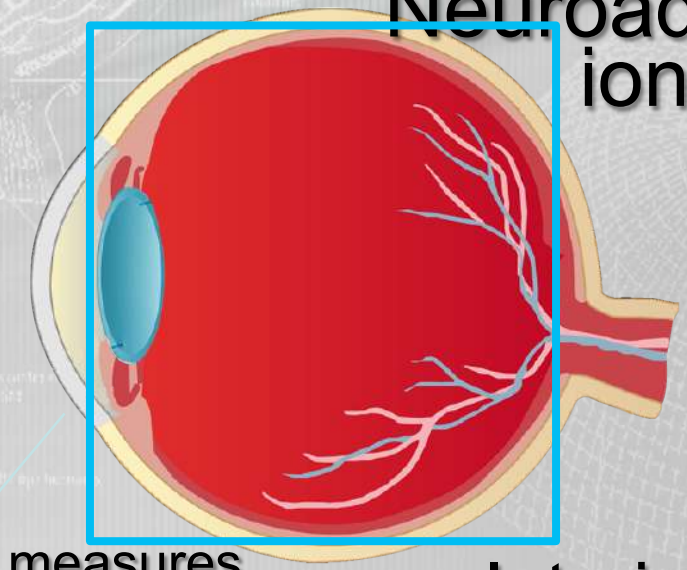


Good contrast sensibility

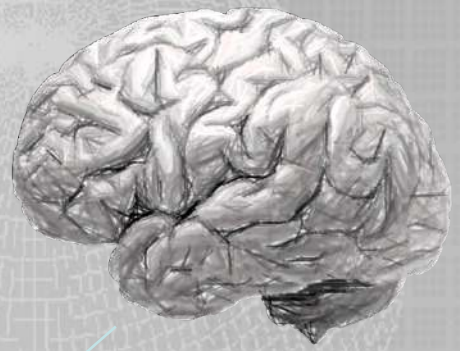
Low contrast sensibility

How can we measure retinal image quality of these multifocal lenses?

Aberrometer



Neuroadaptation



We take inner measures,
Which means that we exclude the Cornea

Interindividual Variability