TORIC IOLS: TIPS AND TRICKS FOR A SUCCESSFUL CORRECTION OF CORNEAL ASTIGMATISM IN CATARACT SURGERY

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I have no economical interests with this presentation

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RESEARCH HOSPITAL

Summary

- Patient selection
- Planning astigmatism correction
- Astigmatism, cornea and age
- Conflicts
- Types of available toric IOLs
- Review of the literature
- Personal results
- Conclusions

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Toric IOLs

- Astigmatic: 30% of the population
- Mean age and quality of life: increase
- Game-changer in management of astigmatism
- Stability and predictability
- May benefit:
  - Patients with an astigmatism >= 1.00 D
  - Post-PK astigmatism
  - With caution but possibly in KC, some irregular astigmatisms

(Goggin M, Arch Ophthalmol 2011)

Patient Selection

- Expectations: realistic
- Promises: positive, admit possible residual astigmatism
- Multifocal toric: double care
- Anterior corneal surface:
  - Regular astigmatism
  - Beware of highly irregular astigmatism
  - Beware of excessive high order aberrations
- Tear film
  - Topography hampered by irregular tear film
  - Dry eye (punctate keratopathy)
- Ocular surface disease: treat before proceeding

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Planning Refractive Target

- Visual target
- Stay on myopic side but emmetropia is goal
- Maintain visual habits (i.e., myopia)
- AR astigmatism myopia: certain amount of near vision provided by astigmatism
- Some remaining astigmatism is commonly present:
  - Nonzero astigmatic targets
  - Variability of axis
  - Power effects of surgical incisions
  - Underestimation of the corneal plane cylinder power of the IOLs by the manufacturer

(Goggin M, Arch Ophthalmol 2011)

Toric IOLs: How

- Subjective refraction
- Accurate biometry
- Corneal topography
- Scheimpflug imaging
- Aberrometry (wavefront)
- Pupillometry, angle K
- Accurate IOL calculation
- Preoperative axis determination
- Accurate intraoperative alignment

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Planning Astigmatism Correction

- Subjective astigmatism
  - May be influenced by lens astigmatism or aberrations
- Corneal astigmatism: Toric IOLs

1. Anterior corneal surface measurement
   - Corneal topography
2. Posterior corneal surface measurement
   - Scheimpflug imaging
3. Aberrometry
   - Verifies internal astigmatism and aberrations
4. Surgically induced astigmatism
   - Know your SIA

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Anterior Corneal Surface Astigmatism

- Major responsible of ocular astigmatism
- Topography measurements:
  - Placido-ring distances
  - Correct head positioning
    - Beware of head tilt (eye: no goniometer !)
    - Expose eye to eliminate nose and eyebrow shadow
  - Tear film irregularities or dry eye may alter images
- Verify reliability: repeat
- Perform topography on all cataract patients (i.e., identify KC)

Posterior Corneal Surface Astigmatism

- Posterior corneal surface contributes to corneal optics in a nonnegligible way
- Generally minor, occasionally high
- Verify !
- Scheimpflug imaging
- Correct head positioning
- Verify reliability: repeat
- Ideally, Scheimpflug on all cataract patients

(Preussner PR, Cataract & Refractive Surgery Today, Jul/Aug 2014)

But… is it all so easy ?

- Wrong belief no. 1: Corneal astigmatism is stable throughout life
  - Corneal astigmatism in healthy subjects changes from with the rule (WR) to against the rule (AR) as years go by.
  - -0.30 D in 10 yrs

(Hayashi K, Am J Ophthalmol 2011)

- Wrong belief no. 2: power of posterior corneal surface is really not important
  - 0.50 D AR in WR corneas
  - 0.30 D AR in AR corneas

(Koch DD, J Cataract Refract Surg.2013 Dec;39(12):1803-9)

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Astigmatism, Cornea and Age

1. Significative Trend towards AR astigmatism with increase of age both for anterior corneal astigmatism and for total astigmatism (mean: -0.18 D e -0.16 D/5 yrs, respectively)
2. Significative Trend towards WR astigmatism for posterior corneal astigmatism (mean: 0.022 D/5 aa).

(Ho JD, Cornea 2010)

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Astigmatism and Cornea

- Anterior Cornea and total corneal values:
  - WR astigmatism decreases with age
  - oblique and AR astigmatism increase with age
- Posterior Cornea :
  - the majority of eyes has AR astigmatism in all age ranges

(Ho JD, Cornea 2010)

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Conflict

1. Check posterior corneal surface astigmatism, and take it into account
2. Slightly less correction of WR anterior corneal astigmatism:
   - Have 0.50 D AR astigmatism in posterior cornea
- Slightly more correction of AR anterior corneal astigmatism:
   - Have 0.30 D AR astigmatism in posterior cornea
- Pentacam and Galilei measurement do not support this yet
- IOL imprecise alignment may play a role

(Koch DD, J Cataract Refract Surg.2013 Dec;39(12):1803-9)

(Holladay JT, Eye World, Aug 2013)

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Thus…

- ASCRS 2012: Douglas Koch, MD
- Baylor nomogram
- Leave a small amount of WR astigmatism (0.25 D, at most 0.50 D)
- Even if changes take place with time, patients want to have good vision now

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But… is it all so easy ?

- Wrong belief no. 3: sutureless cataract srgrey, with temporal incision, induces WR astigmatism
  - True for a certain amount of time: corneal astigmatism after surgery shows the same change from WR to AR observed in healthy subjects (10 year study)

(Hayashi K, Am J Ophthalmol 2011)

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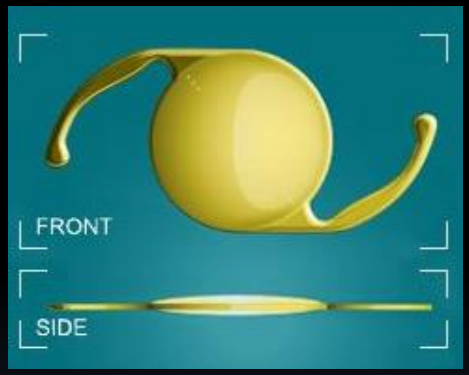
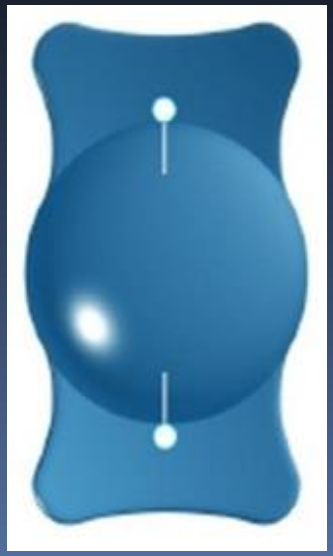
Types of Available Toric IOLs

- SN60TT AcrySof IQ Toric
  1. Posterior toric lens surface
  2. Anterior aspheric surface
  3. Range: 1.50 – 3.00 cyl



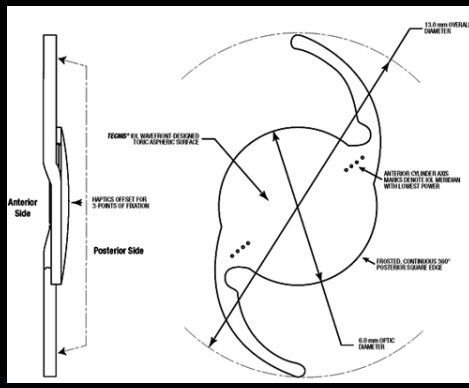
- AcrySof IQ ReSTOR Toric
  1. Biconvex, apodized diffractive aspheric toric
  2. Range: 1.00 – 3.00 cyl

- Zeiss AT TorBi 709 M toric IOL
  1. Bitoric aspheric (prolate)
  2. Equally convex optic
  3. Hydrophilic acrylic, hydrophobic Surface
  4. Range: +1.00 - +12.00 cyl
- Zeiss AT Lisa 909 M toric IOL
  1. Diffractive multifocal



Types of Available Toric IOLs

- Tecnis multifocal toric 1-piece ZMT
- Biconvex, anterior toric aspheric surface
- Range: 1.00 – 4.00 D cyl

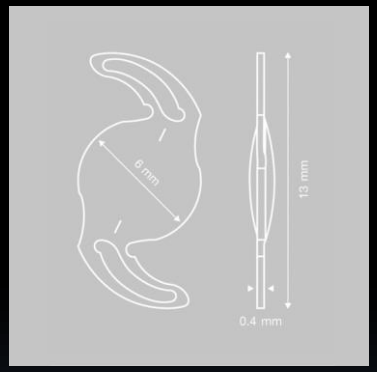


- Finevision toric
- Aspheric, diffractive trifocal
- 25% hydrophilic acrylic
- Square edge
- Incision size: 1.8 mm

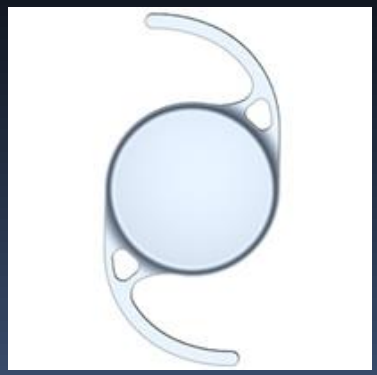
- ANKORIS
- Biconvex aspher
- -0.11 mu SA
- 26% hydrophilic acrylic
- Range: 1.50 – 6.00 cyl

Types of Available Toric IOLs

- Aspheric Bi-Flex T (677 TA)
- Aspheric hydrophilic acrylic
- Mono- or bitoric
- 25% water content



- Bausch & Lomb enVista
- Hydrophobic acrylic IOL
- Aberration free
- Glistening-free



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Review of the Literature

- Cyl reduction: 2.05 D

Preop D	Postop D	Eyes	Toric IOL	Author	Year	Journal	
1.60 ±1.20	0.40 ±0.60	230	AcrySof	Gayton JL	2011	JRS	Simple and complex
1.70 ±0.4	0.4 ±0.4	234	AcrySof	Ahmed II	2010	JCRS	bilateral
4.6 ±2.3	1.12 ±0.9	68	MicroSil	Dick HB	2006	Klin Monbl	
4.00 ±1.10	0.55 ±0.60	19	AcrySof SN60T	Cervantes-Coste G	2012	JRS	
2.39 ±1.48	-0.49 ±0.53	284	AT Lisa 909M	Bellucci R	2013	JCRS	
1.93 ±0.90	0.30 ±0.54	30	Bi-Flex T	Bachernegg A	2013	JCRS	
2.17 ±0.41	0.73 ±0.45	30	AcrySof TT	Toto L	2013	JCRS	

Review of the Literature

- Mean UCVA (2010 -2013): 0.19 logMAR

UCVA logMAR	MOS	Eyes	Toric IOL	Author	Year	Journal
0.33 ± 0.18	13.3	30	AcrySof Toric	Kim MH	2010	KJO
0.2	6	30	AcrySof Toric SN60TT	Koshy JJ	2010	JCRS
0.13 ± 0.10	3	40	AcrySof SN60T	Mingo-Botin D	2010	JCRS
0.23 ± 0.23	4	33	Rayner T-Flex 623T	Entabi M	2011	JCRS
0.16 ±0.22	6	284	AT Lisa 909M	Bellucci R	2013	JCRS
0.11 ±0.09	3	19	AcrySof SN60T	Cervantes-Coste G	2012	JRS
0.05 ±0.12	3	30	Bi-Flex T	Bachernegg A	2013	JCRS
0.20	6	30	AcrySof T	Toto L	2013	JCRS
0.3	3	72	AcrySof SN6At, AT Torbi 709M	Scialdone A	2013	JCRS

Review of the Literature

- IOL Alignement

% > ±5°	% > ±10°	Eyes	Mos	Toric IOL	Author	Year	Journal	
91.1	100	161	6	AcrySof	Ahmed II	2010	JCRS	bilat
90	99	100	1	AcrySof SN60T	Chang DF	2008	JCRS	
70	90	90	1	AA4203	Chang DF	2008	JCRS	
85	99	68	3	MicroSil	Dick HB	2006	Klin M.	
	100	40	2	Tecnis T, AcrySof IQ T	Ferreira TB	2012	JRS	
37.0		26	3	Staar silicone	Chua WH	2012	JCRS	
95.8		284	6	AT Lisa 909M	Bellucci R	2013	JCRS	
61.1		36	3	AcrySof SN6AT	Scialdone A	2013	JCRS	
66.6		36	3	AT Torbi 709 M	Scialdone A	2013	JCRS	

Review of the Literature

- Mean IOL rotation: 4.45°

Mean rotation °	Eyes	Mos	IOL	Author	Year	Journal	
3.35 ±3.41	100	1	SN60T,	Chang DF	2008	JCRS	
5.56 ±8.49	90	1	AA4203	Chang DF	2008	JCRS	
3.15 ±2.62	20	2	Tecnis	Ferreira TB	2012	JRS	
3.25 ±2.04	20	2	AcrySof IQ T	Ferreira TB	2012	JRS	
4.23 ±4.28	24	3	AcrySof	Chua WH	2012	JCRS	
9.42 ±7.80	26	3	Staar silicone	Chua WH	2012	JCRS	
2.12 ±3.45	30	3	Bi-Flex T	Bachernegg A	2013	JCRS	

Review of the Literature

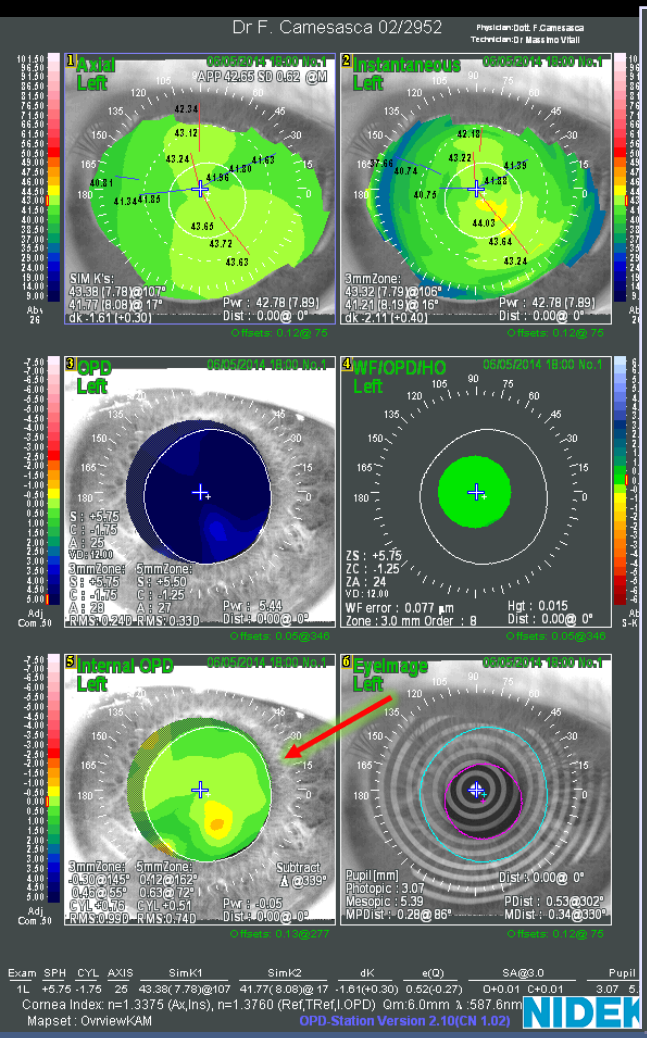
- Induction of refractive defect
- Misalignement of toric IOL:
  - 10° error: 34% error
  - Reduction in astigmatic correction
  - Hyperopic spherical change
  - Astigmatic rotation

  Jin H, J Cataract Refract Surg 2010

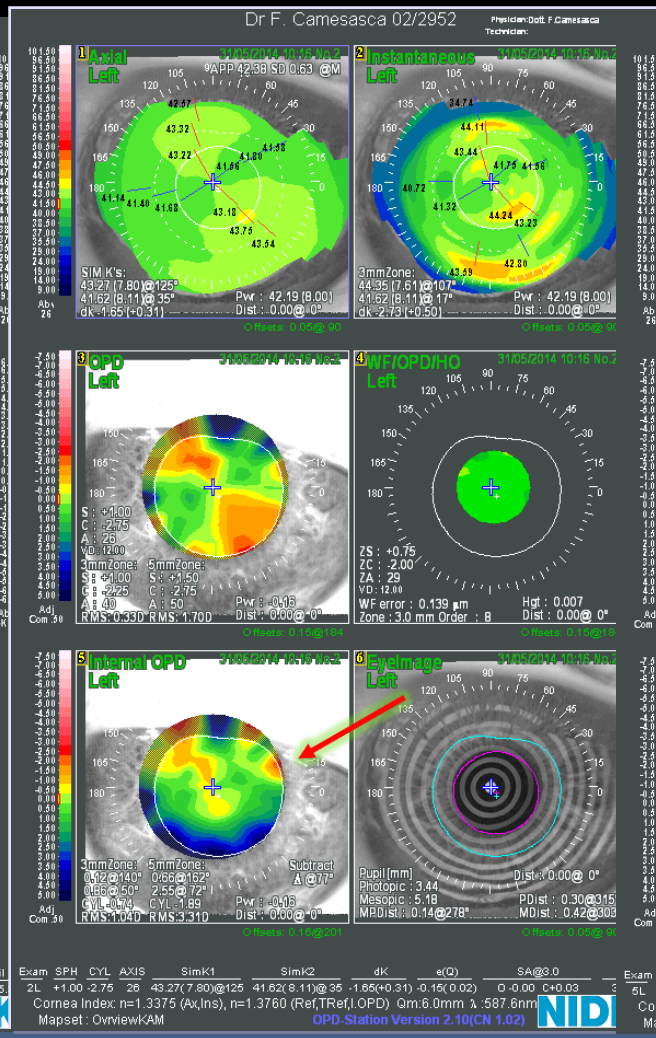
- Toric IOL rotation of less than 10° changed eye refraction of less than 0.50 D

  Felipe A, J Cataract Refract Surg 2011

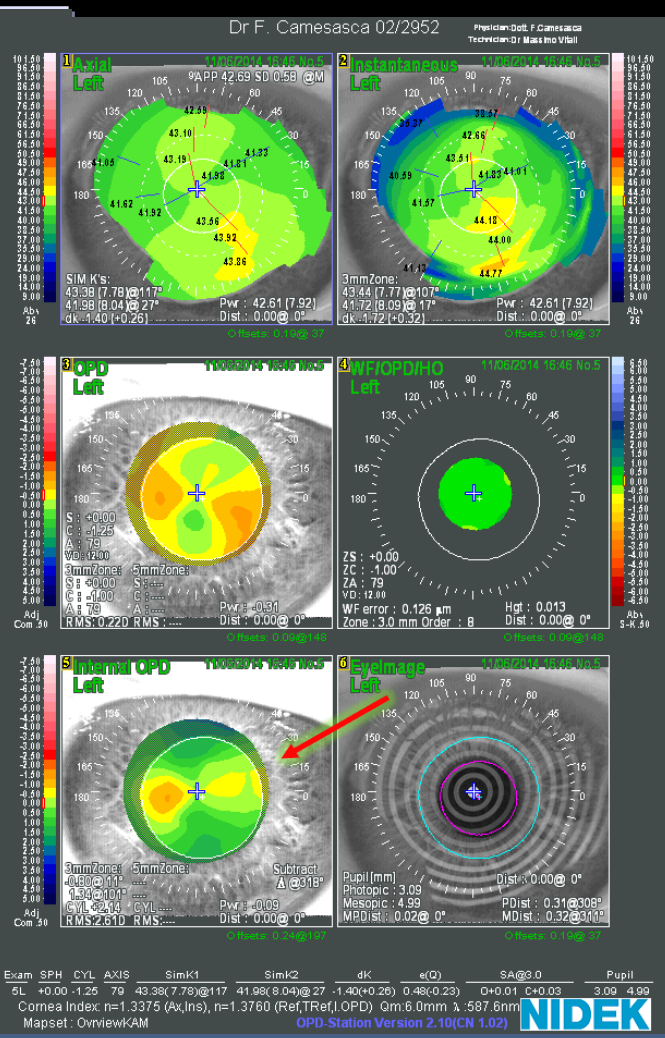
Alignment Error



+5.75 -1.75 (25)



+1.00 -2.75 (26)



+0.00 -0.75 (79)

Review of the Literature

- Commonly used three-step ink-marker procedure: mean error in IOL placement: 5°

Visser N, J Cataract Refract Surg 2011

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Personal Results

- Precise intraoperative toric IOL axis orientation:
  - May be haphazardous
  - Complicated
  - Time-consuming
  - Every degree of misalignement leads to residual astigmatism and sphere
- Limbal vessels pattern may be a precise referral structure for proper axis alignement.

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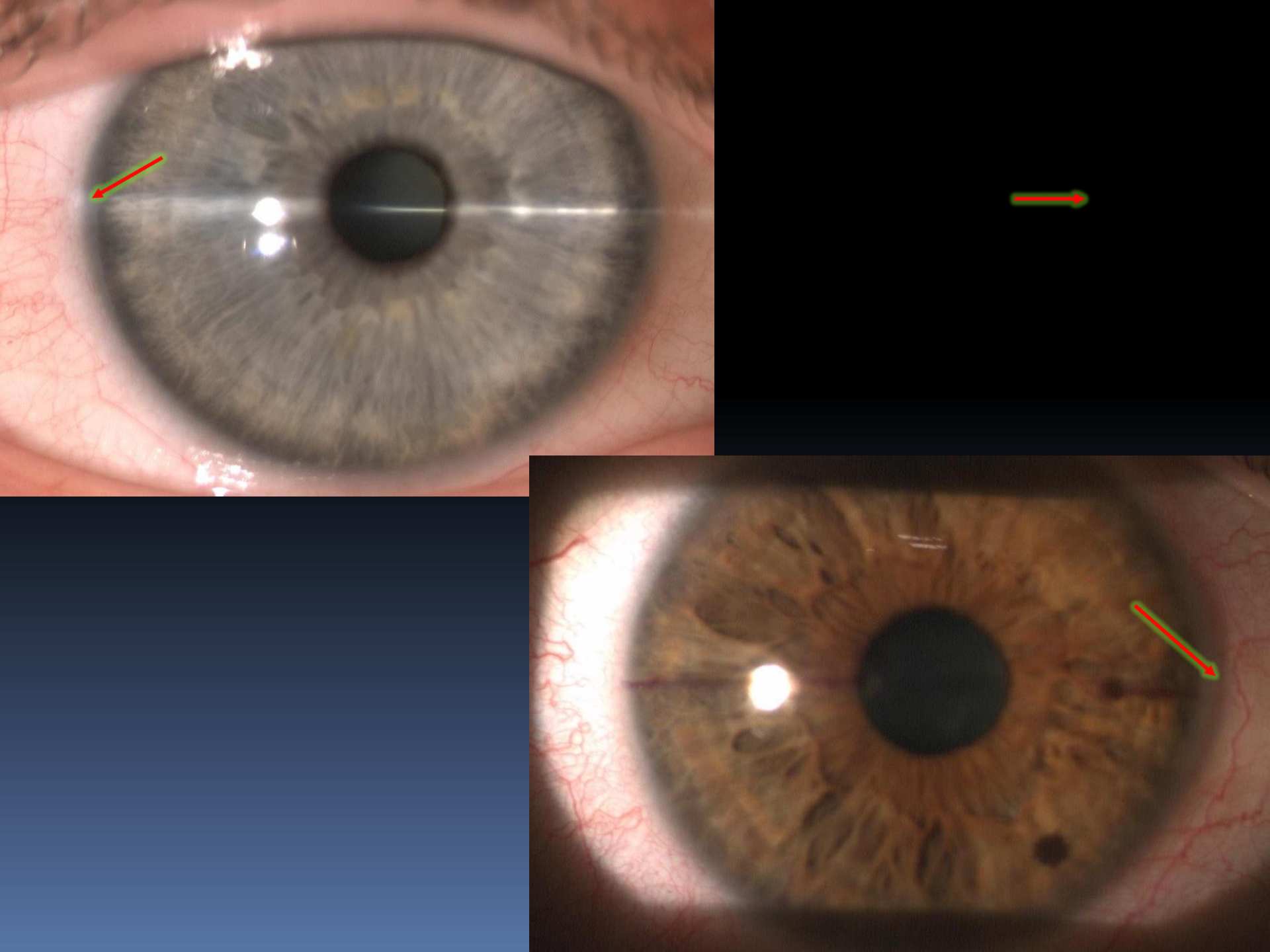

Purpose of the study

- Evaluate:
  - subjective and objective refraction
  - topographic astigmatism (TA)
  - before and after implantation of toric aspheric monofocal IOL
  - aligned with an empirical method based on the limbal vessels pattern.

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Materials and Methods

1. IOL Aligment
    1. Preoperative identification of topographic axis of astigmatism
    2. Slit-lamp identification and photograph of limbal vessels in correspondence of the most curve axis of astigmatism
    3. Preoperative mark of 0° - 180° axis
    4. Intraoperative detection of involved limbal vessel and IOL alignement

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Materials and Methods

1. Thirty-six eyes (20 patients, mean age 64.35 ± 16.59)
2. 2.2 mm incision surgery
3. Toric aspheric monofocal IOL (Zeiss AT Torbi 409 MP)
4. Mean power: +16.33 D ± 7.57 D, -2.75 D ± 0.27 D cyl.
5. Preoperatively:
    1. Reference limbal vessels positioned in correspondance of the alignment axis recommended by the specific website software (Zeiss Z Calc) were photographed.
6. IOL axis orientation:
    1. Aligning the axis with reference limbal vessels
    2. Checking preoperative corneal topography astigmatism
7. Subjective refraction and TA were measured before and nine months after surgery.

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Results

1. Mean preoperative subjective refraction:-2.29 D ± 3.63 D sph with -2.19 D ± 0.55 D cyl at 64.44° ± 72.73°
2. Mean TA: -1.79 ± 0.39 at 118.88° ± 73.82° . Mean SIA was -0.20 D
3. Postop. (9 ± 4 months), mean subj. refraction was -0.41 D ± 0.79 D sph with -0.25 D ± 0.44 D cyl at 93.33° ± 45.09° .
4. Mean BSCVA and UCVA were -0.06 LogMar and -0.02 LogMar, respectively.
5. Mean TA was -1.87 D ± 0.40 D at 134.25° ± 63.90° .
6. Mean IOL axial orientation was at 90.83° ± 38.40° .

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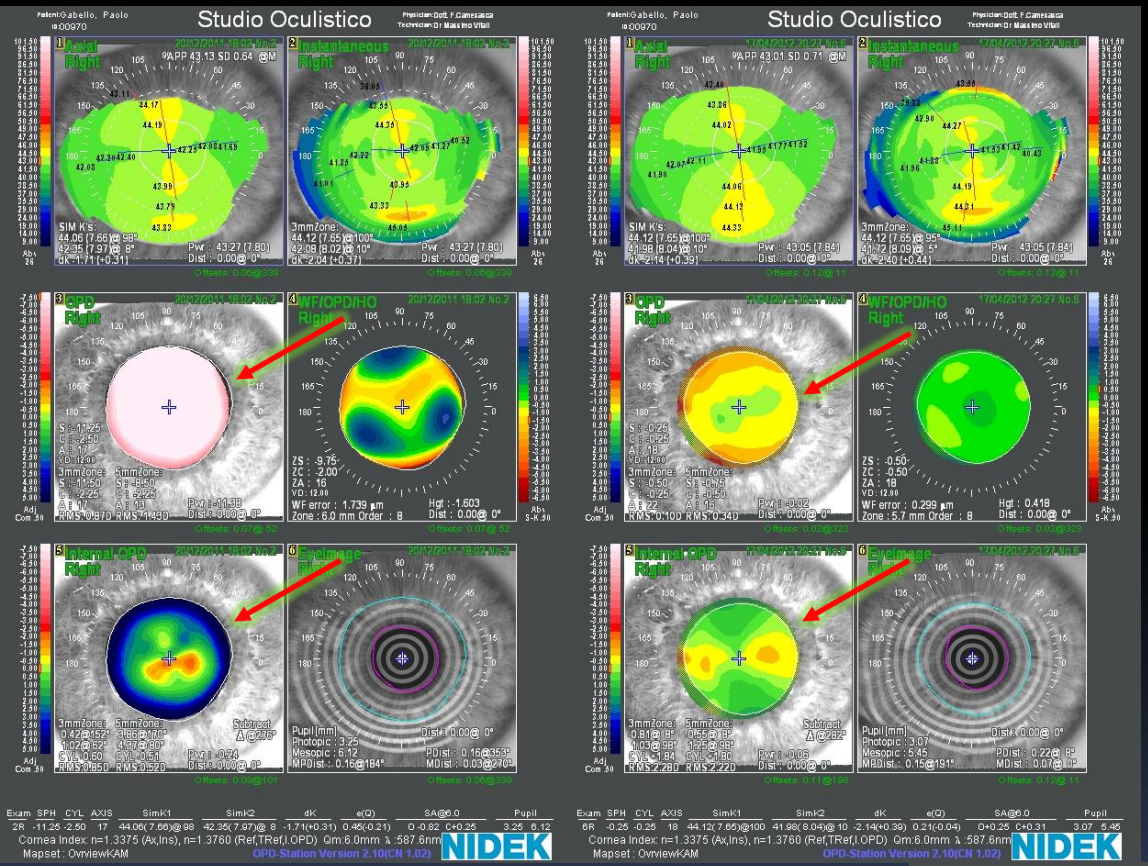
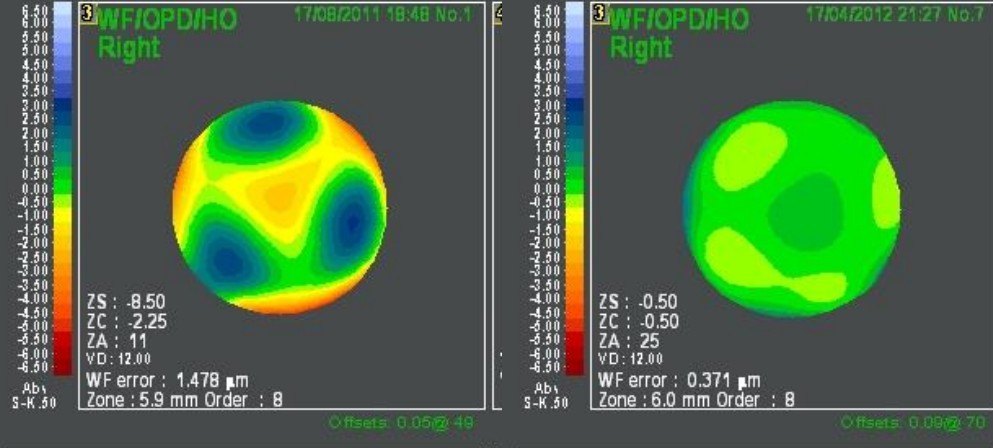
-11.25 -2.50 (170) -0.25 -0.25 (18)



6 mos FUP

VOD 0.1 LogMar

Wavefront



Study Conclusions

1. Patients receiving monofocal toric IOLs aligned through an empirical method reached optimal visual acuity.
2. Mean TA was not influenced by SIA
3. Final refraction showed highly satisfactory correction of spherical and astigmatic defect.

(van Gaalen KW, J Cataract Refract Surg 2010)

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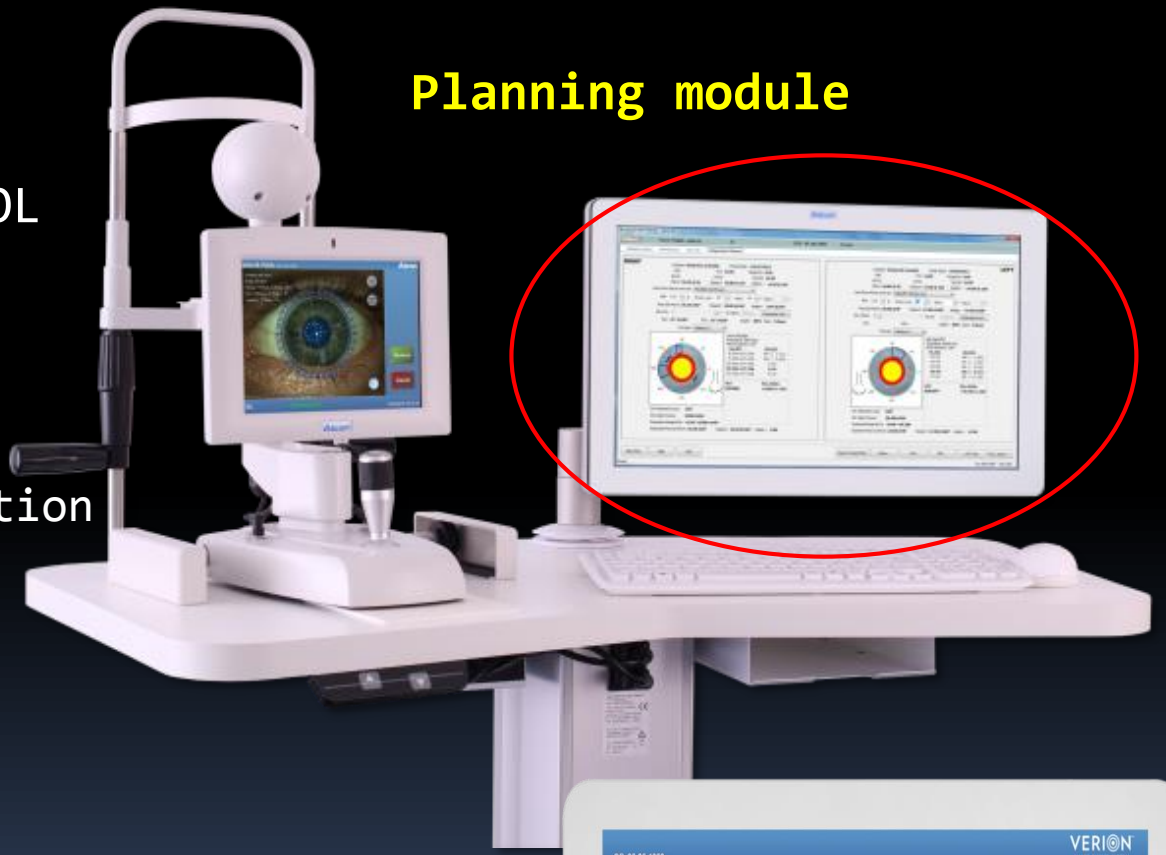
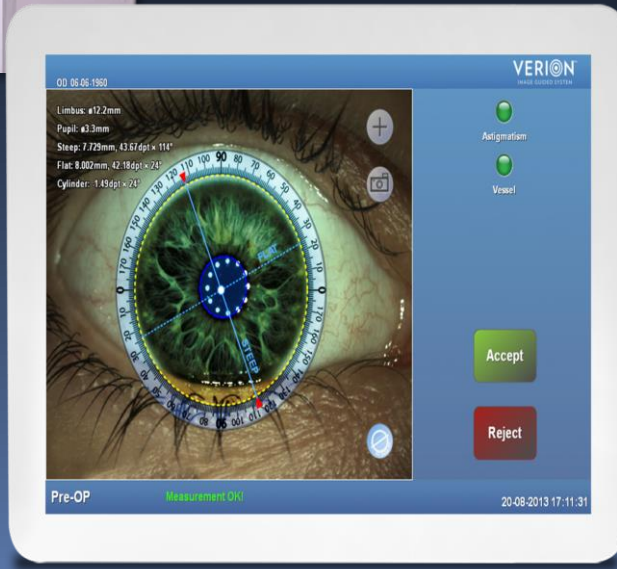
Verion

- Treatment planning- IOL



Principal features:

- Power and IOL type selection
- **Optimization of SIA - SF**
- Available formulas
  - Holladay 1, 2, R
  - Hoffer Q
  - SRK-T
  - Haigis
- Advanced astigmatism management
  - Toric IOL
  - Clear Corneal Relaxing Incisions
  - Combination of both(for LenSx)
- Export of surgical plan
  - Available with Surgery Pilot LenSx e MID



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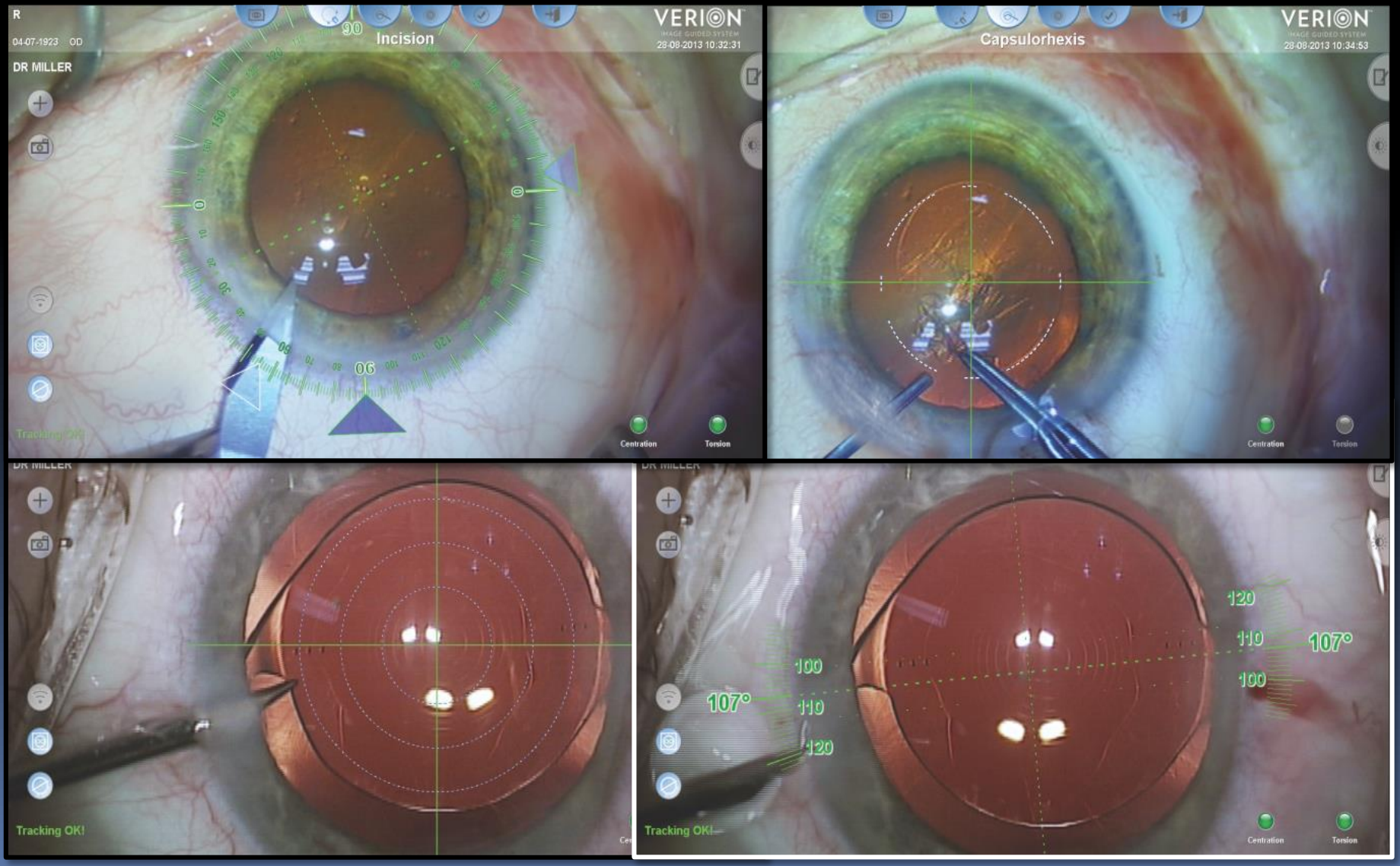

Conclusions

- Toric IOLs are an effective way to correct astigmatism
- Precise alignement mandatory
- IOL calculation will improve
- Posterior corneal surface to be considered
- Several IOLs available, with different ease of positioning
- Excellent visual acuity
- Possible residual astigmatism
- Limited postoperative rotation

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In the Future

1. Toric IOL calculators will take into account posterior corneal astigmatism
2. Intraoperative aberrometry and dioptrical power after cristalline lens removal (ORA, Clarity)
3. Improved knowledge about ocular optical components and their interaction in time
4. Improved nomograms and calculation systems
5. Tailoring refraction for the single patient, his/hers lifestyle and life expectation
6. Cataract surgery = refractive surgery

Thank You For Your Attention !!

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