

POSTERIOR CORNEAL CHANGES IN SUPERIOR VS. TEMPORAL INCISIONS

The success of refractive lens surgery depends on accurate pre-operative keratometric readings and predictable post-phacoemulsification keratometric changes.

The majority of older cataract patients have against-the-rule (ATR) corneal astigmatism, with the steep meridian oriented along or close to 180°. With the advent and improvement of multifocal IOL technology offering one-in-all refractive solutions for presbyopia, myopia and astigmatism, refractive cataract or lens exchange patients are presenting progressively earlier. These younger patients often have with-the-rule (WTR), with the steep meridian oriented along or close to 90°.

Most refractive cataract surgeons are divided in opinion as to placement of phaco incisions, some adhering to a well entrenched dogma of operating on the steep meridian, which, in the case of younger patients, is often vertical, necessitating a superior incision.

The effect of incision placement on anterior K readings is well documented, with superior 3.5 mm incisions correcting as much as 1.5D of WTR astigmatism.¹ More recent data indicates superior 2.8 mm incisions correct as much as 0.75D of WTR astigmatism whilst temporal and nasal incisions remain relatively astigmatically neutral.²

Total corneal astigmatism is the sum of both the anterior and posterior astigmatism, and is of value as it influences post operative refraction.

In this article, we would also like to illustrate some of the possible changes the posterior cornea undergoes with different incision locations that should be taken into

account when planning refractive cataract surgery.

Case 1

A 52-year-old lady with myopia and early cataracts presented for left refractive lens exchange. Keratometry was determined with the Galilei G4 combined Placido/Dual Scheimpflug Analyser (Ziemer AG, Port, Switzerland) which was then fed into the Lenstar LS900 optical biometer (Haag-Streit, U.S.A).

Keratometry revealed anterior WTR astigmatism of 0.54D and negligible ATR posterior corneal astigmatism. (Figure 1) During surgery, a 2.75 mm on-axis superior corneal incision was made, and a diffractive trifocal IOL implanted. On the first post-operative day, her uncorrected distance visual acuity (UCDVA) was 0.3 logMAR which did not improve at 1 week. Manifest refraction was plano/-1.50 x 090.

A repeat Galilei scan revealed flipping of the anterior keratometric axis, with significant increase of the anterior corneal astigmatism (0.54D pre-op to 1.17D post-op). Crucially, there was steepening of the posterior corneal surface with increase in ATR posterior corneal astigmatism (0.25D to 0.91D). The steepening was localized and involved the central 3 mm zone. (Figure 2)

Case 2

A 49-year-old lady with myopia and early cataracts presented for right refractive lens exchange. IOL power was calculated combining keratometry from the Galilei G4 and axial length from the Lenstar.

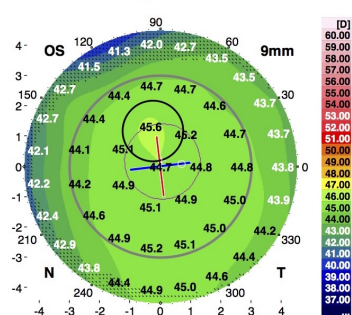
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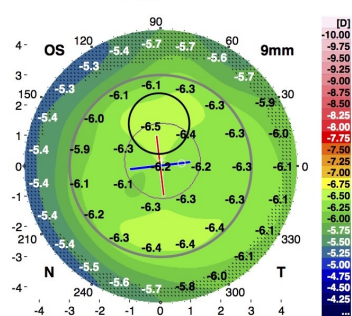
SW V6.3.1

GALILEI G4

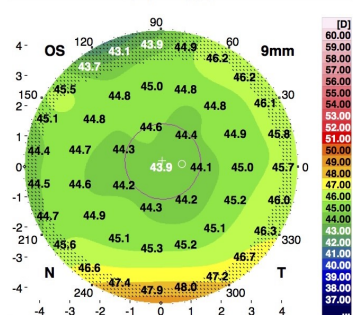
Anterior Axial Curvature [D] n 1.3375



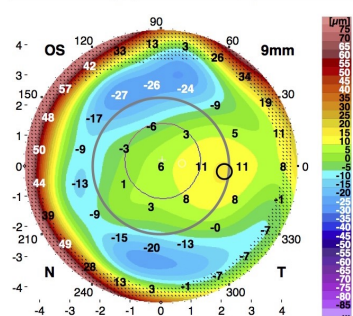
Posterior Axial Curvature [D]



Total Corneal Power IOL (Ray Traced) [D]



Post. Elevation BFS [μm] Fit Zone 8.0 mm | RadiusBFS 6.51 mm



SimK n 1.3375

SimK 45.07D	R 7.49mm
Flat SimK 44.80D	R1 7.53mm
Steep SimK 45.34D	R2 7.44mm
Astig 0.54D	e ² (-Q) 0.12

Anterior Axial Curvature Zones n 1.3375

Central 45.06D	7.49mm
Mid 44.65D	7.56mm
Periph 43.03D	7.84mm
Kmax 45.65D	7.39mm location x,y -0.25mm 0.87mm

Posterior Axial Curvature

Mean K -6.32D	R 6.33mm
Flat K -6.19D	R1 6.46mm
Steep K -6.44D	R2 6.21mm
Astig -0.25D	e ² (-Q) 0.40

Pachymetry

o Thinnest 487μm	x,y 0.69mm 0.09mm
Central 496μm	CCT 489μm
Mid 536μm	
Periph 599μm	Corneal Vol. 28.0mm ³

Total Corneal Power IOL (Ray Traced)

Mean TCPIOL 44.21D	Central 44.14D
Flat TCPIOL 44.03D	Mid 44.97D
Steep TCPIOL 44.38D	Periph 45.61D
Astig 0.34D	97°

Anterior Chamber and Biometry

WTW, N-T 11.81mm	Mean Angle 29.7°
ACV 89mm ³	Kappa Dist 0.20mm
AQD 2.54mm	ASL endo n/a
+ Pupil Diam 2.49mm	location x,y 0.04mm 0.20mm

Keratoconus Probability

CLMlaa 0.35D	PPK 0.3%
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Exam Label and Notes

Figure 1: Mild WTR anterior and negligible ATR posterior astigmatism

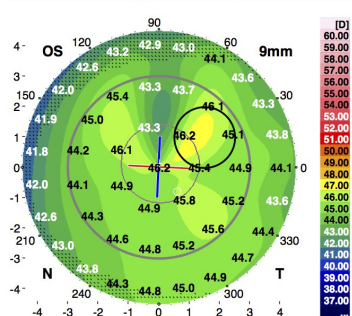
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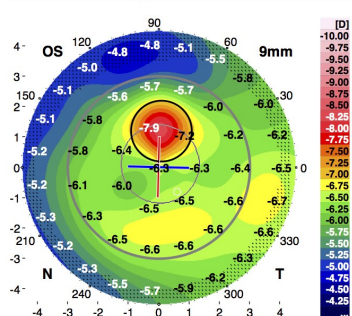
SW V6.3.1

GALILEI G4

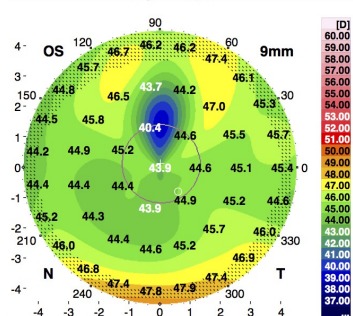
Anterior Axial Curvature [D] n 1.3375



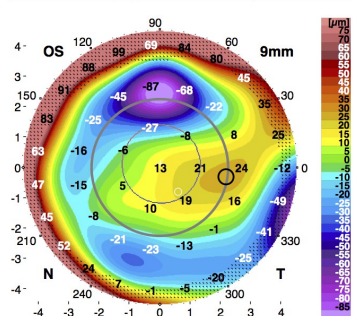
Posterior Axial Curvature [D]



Total Corneal Power IOL (Ray Traced) [D]



Post. Elevation BFS [μm] Fit Zone 8.0 mm | RadiusBFS 6.47 mm



SimK n 1.3375

SimK 44.56D	R 7.57mm
Flat SimK 43.67D	R1 7.73mm
Steep SimK 45.45D	R2 7.43mm
Astig 1.78D	e ² (-Q) 0.19

Anterior Axial Curvature Zones n 1.3375

Central 45.20D	7.47mm
Mid 44.75D	7.54mm
Periph 43.17D	7.82mm
Kmax 47.08D	7.17mm location x,y 1.24mm 1.01mm

Posterior Axial Curvature

Mean K -6.75D	R 5.93mm
Flat K -6.30D	R1 6.35mm
Steep K -7.20D	R2 5.55mm
Astig -0.91D	89° e ² (-Q) 0.54

Pachymetry

o Thinnest 520μm	x,y 0.60mm -0.80mm
Central 537μm	CCT 526μm
Mid 589μm	
Periph 627μm	Corneal Vol. 30.5mm ³

Total Corneal Power IOL (Ray Traced)

Mean TCPIOL 43.14D	Central 43.96D
Flat TCPIOL 41.63D	Mid 45.10D
Steep TCPIOL 44.65D	Periph 45.87D
Astig 3.02D	178°

Anterior Chamber and Biometry

WTW, N-T 11.66mm	Mean Angle 37.6°
ACV n/a	Kappa Dist 0.13mm
AQD n/a	ASL endo n/a
+ Pupil Diam 2.58mm	location x,y 0.02mm 0.13mm

Keratoconus Probability

CLMlaa 1.38D	PPK 2.9%
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Exam Label and Notes

Figure 2: Moderate ATR anterior astigmatism, increased ATR posterior astigmatism with localized steepening encroaching central cornea

Keratometry revealed severe anterior WTR astigmatism of 2.61D and mild posterior ATR astigmatism of 0.56D. (Figure 3) A temporal 2.75 mm incision was made, and a toric progressive multifocal IOL was placed. Post operative day 1, her UCDVA was 0.0 logMAR, with uncorrected near visual acuity (UCNVA) J2 at 40cm. Manifest refraction was -0.25/-0.50 x 175.

Repeat Galilei scan revealed minimal anterior keratometric change (2.61D pre-op to 2.36D post-op, with no axis flipping), and crucially, negligible posterior keratometric change (0.56D pre-op to 0.58D post-op). (Figure 4)

Case 3

A 69-year-old lady with myopia and significant cataracts presented for right cataract surgery.

IOL power was calculated combining keratometry from the Galilei G4 and axial length from the Lenstar.

Keratometry revealed mild anterior WTR corneal astigmatism of 0.62D and mild posterior corneal ATR astigmatism of 0.47D. (Figure 5) A temporal 2.75 mm incision was made and an aspheric monofocal IOL was placed. Surgery was uncomplicated, and on the first-operative day, her UCDVA was 0.1 logMAR, with no subjective improvement at 1 week.

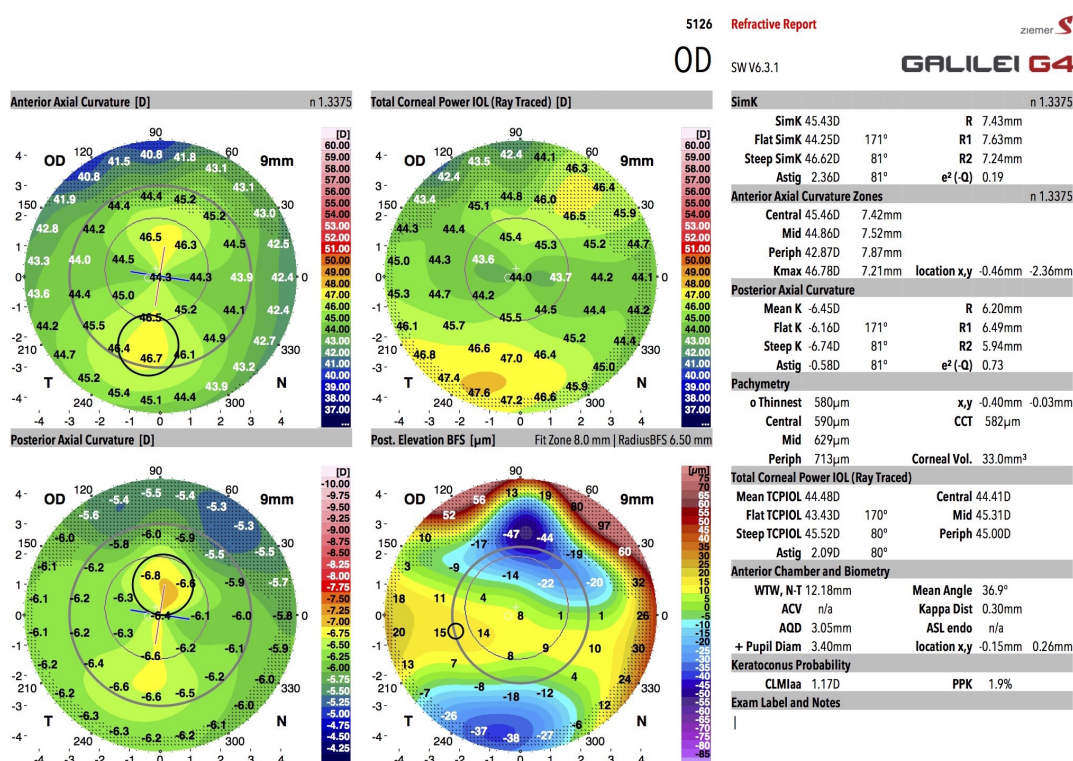


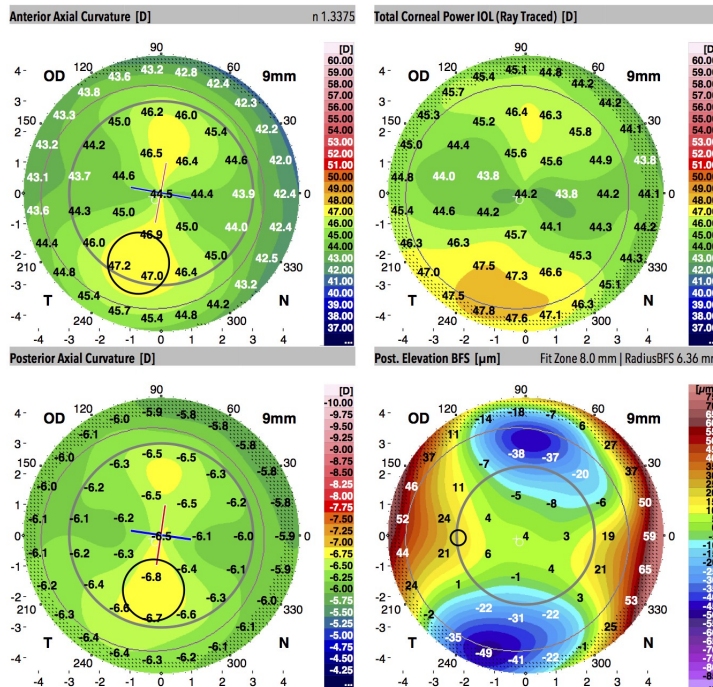
Figure 3: Severe WTR anterior and mild ATR posterior astigmatism

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GALILEI G4



SimK				n 1.3375	
SimK	45.61D		R	7.40mm	
Flat SimK	44.30D	170°	R1	7.62mm	
Steep SimK	46.91D	80°	R2	7.19mm	
Astig	2.61D	80°	e ² (-Q)	0.16	
Anterior Axial Curvature Zones				n 1.3375	
Central	45.53D	7.41mm			
Mid	45.19D	7.47mm			
Periph	43.20D	7.81mm			
Kmax	47.36D	7.13mm	location x,y	-0.86mm	-2.13mm
Posterior Axial Curvature					
Mean K	-6.42D		R	6.23mm	
Flat K	-6.15D	172°	R1	6.51mm	
Steep K	-6.70D	82°	R2	5.97mm	
Astig	-0.56D	82°	e ² (-Q)	0.64	
Pachymetry					
o Thinnest	580μm		x,y	-0.20mm	-0.22mm
Central	588μm		CCT	581μm	
Mid	623μm				
Periph	685μm		Corneal Vol.	32.6mm ³	
Total Corneal Power IOL (Ray Traced)					
Mean TCPIOL	44.71D		Central	44.52D	
Flat TCPIOL	43.51D	170°	Mid	45.50D	
Steep TCPIOL	45.91D	80°	Periph	45.19D	
Astig	2.40D	80°			
Anterior Chamber and Biometry					
WTW, N-T	12.21mm		Mean Angle	43.7°	
ACV	n/a		Kappa Dist	0.32mm	
AOD	3.14mm		ASL endo	6.32mm	
+ Pupil Diam	7.28mm		location x,y	-0.30mm	-0.11mm
Keratoconus Probability					
CLMlaa	0.91D		PPK	1.1%	
Exam Label and Notes					

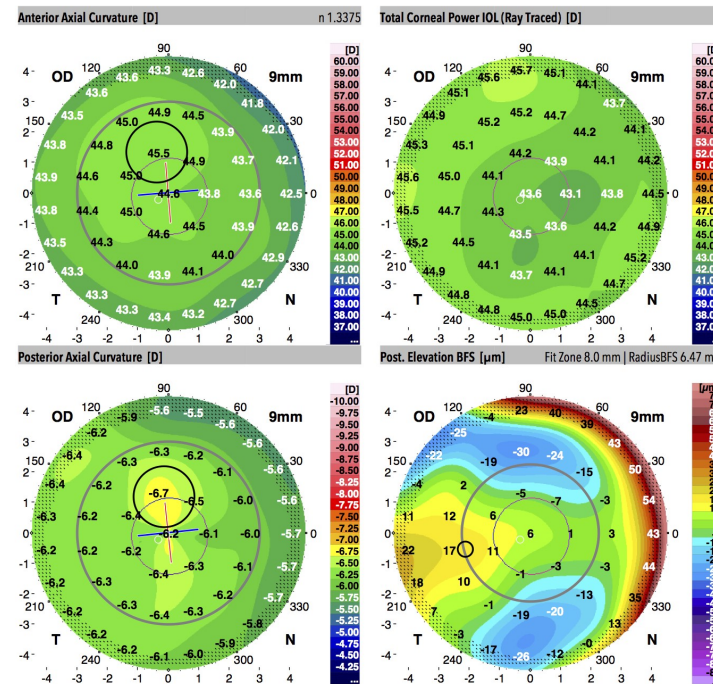
Figure 4: Negligible change in both anterior and posterior astigmatism

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SWV6.3.1

GALILEI G4



SimK				n 1.3375	
SimK	44.75D		R	7.54mm	
Flat SimK	44.45D	5°	R1	7.59mm	
Steep SimK	45.06D	95°	R2	7.49mm	
Astigm	0.62D	95°	e ² (-Q)	0.30	
Anterior Axial Curvature Zones				n 1.3375	
Central	44.84D	7.53mm			
Mid	44.21D	7.63mm			
Periph	42.77D	7.89mm			
Kmax	45.48D	7.42mm	location x,y	-0.17mm	1.09mm
Posterior Axial Curvature					
Mean K	-6.39D		R	6.26mm	
Flat K	-6.15D	6°	R1	6.50mm	
Steep K	-6.63D	96°	R2	6.03mm	
Astigm	-0.47D	96°	e ² (-Q)	0.58	
Pachymetry					
o Thinnest	572μm		x,y	-0.34mm	-0.22mm
Central	581μm		CCT	572μm	
Mid	619μm				
Periph	673μm		Corneal Vol.	32.4mm ³	
Total Corneal Power IOL (Ray Traced)					
Mean TCPIOL	43.74D		Central	43.76D	
Flat TCPIOL	43.64D	1°	Mid	44.43D	
Steep TCPIOL	43.84D	91°	Periph	44.74D	
Astigm	0.20D	91°			
Anterior Chamber and Biometry					
WTW, N-T	11.84mm		Mean Angle	29.0°	
ACV	101mm ³		Kappa Dist	0.09mm	
AOD	2.56mm		ASL endo	n/a	
+ Pupil Diam	2.51mm		location x,y	0.02mm	-0.09mm
Keratoconus Probability					
CLMlaa	0.86D		PPK	1.0%	
Exam Label and Notes					

Figure 5: Mild WTR anterior and mild ATR posterior astigmatism

Galilei scan at 1 week was instructive. Though there was localized steepening of the posterior cornea at the incision site, it did not encroach the central 3 mm zone.

Keratometry remained relatively intact, with minimal anterior corneal changes (0.62 to 0.84D WTR) and mild posterior corneal changes (0.47D pre-op to 0.20D post-op). (Figure 6)

Discussion

The relatively neutral temporal incision is well documented. However, in the mentioned cases, we have demonstrated that unwanted steepening of the posterior cornea may occur regardless of incision location.

The above cases are instructive. Apart from suggested effects of gravity and the eyelid on superior incisions, the shorter vertical dimensions of the cornea, deep set eyes and prominent eyebrows often cause superior incisions to be placed anteriorly, with the inner wound edge encroaching into the central zone. This may necessitate steep angulation of the phaco probe, especially in myopic patients, with resulting localized distortion of the inner wound lip.

Temporal incisions tend to be more peripherally placed, in part due to ease of access and longer horizontal diameter. In addition, because the steepening effect is localized, peripheral incisions tend to have smaller effects on the central cornea.

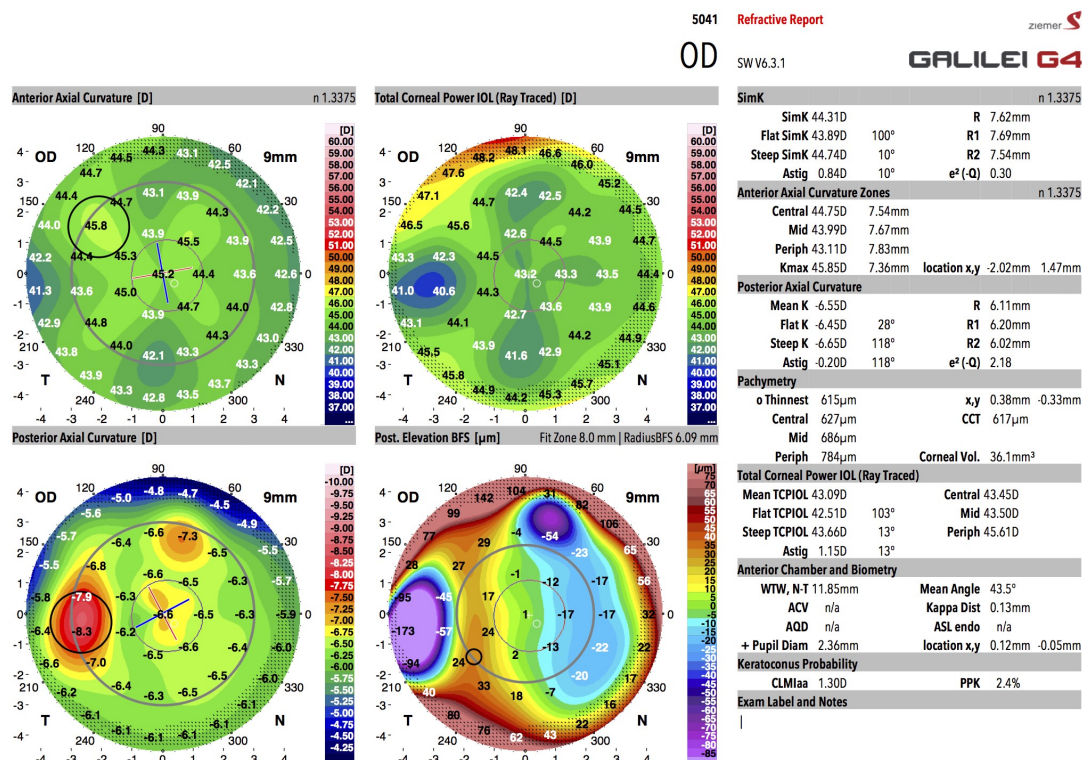


Figure 6: Negligible change in both anterior and posterior astigmatism with localized steepening peripheral, no encroachment of central cornea

Conclusion

Refractive lens or cataract surgery depends on predictable keratometric changes. When planning the incision location, possible posterior corneal changes should be taken into consideration. Out of necessity, superior incisions may often be placed more anteriorly, increasing the risk of unwanted central posterior corneal changes influencing the central cornea.

References

1. Jaime Tejedor, Juan Murube. *Choosing the Location of Corneal Incision Based on Preexisting Astigmatism in Phacoemulsification*. American Journal of Ophthalmology. May 2005. Volume 139, Issue 5, Pages 767–776
2. Jaime Tejedor; José A. Pérez-Rodríguez. *Astigmatic Change Induced by 2.8-mm Corneal Incisions for Cataract Surgery*. Investigative Ophthalmology & Visual Science March 2009, Vol.50, 989-994. doi:10.1167/iovs.08-2778



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