Misalignment tolerability of two monofocal toric IOLs

An analysis of data from astigmatismfix.com

Brent A. Kramer, MD
David R. Hardten, MD, FACS
John P. Berdahl, MD

Financial Disclosure

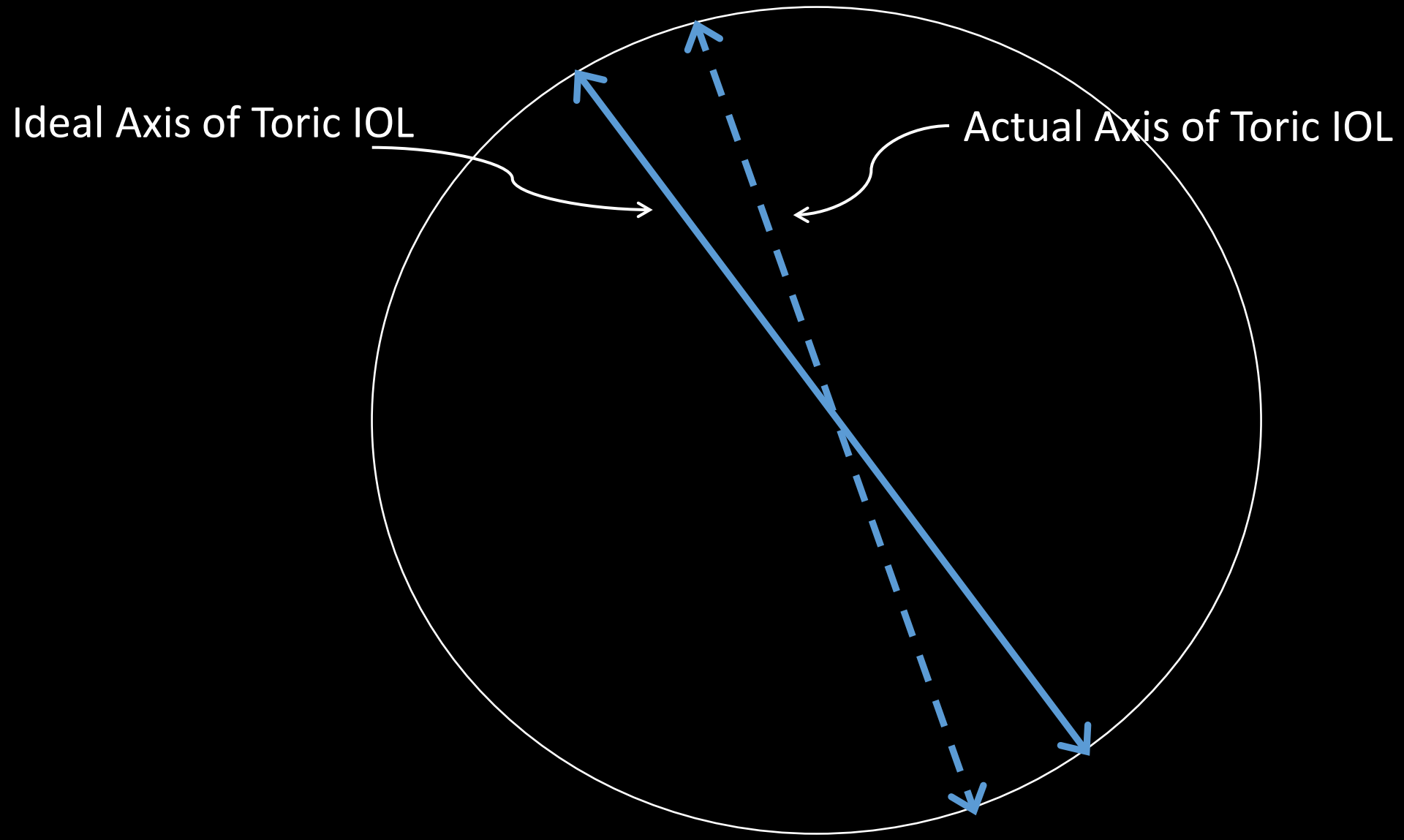
- Data analysis was supported with an investigator-initiated grant from Alcon (Fort Worth, USA)

Purpose:

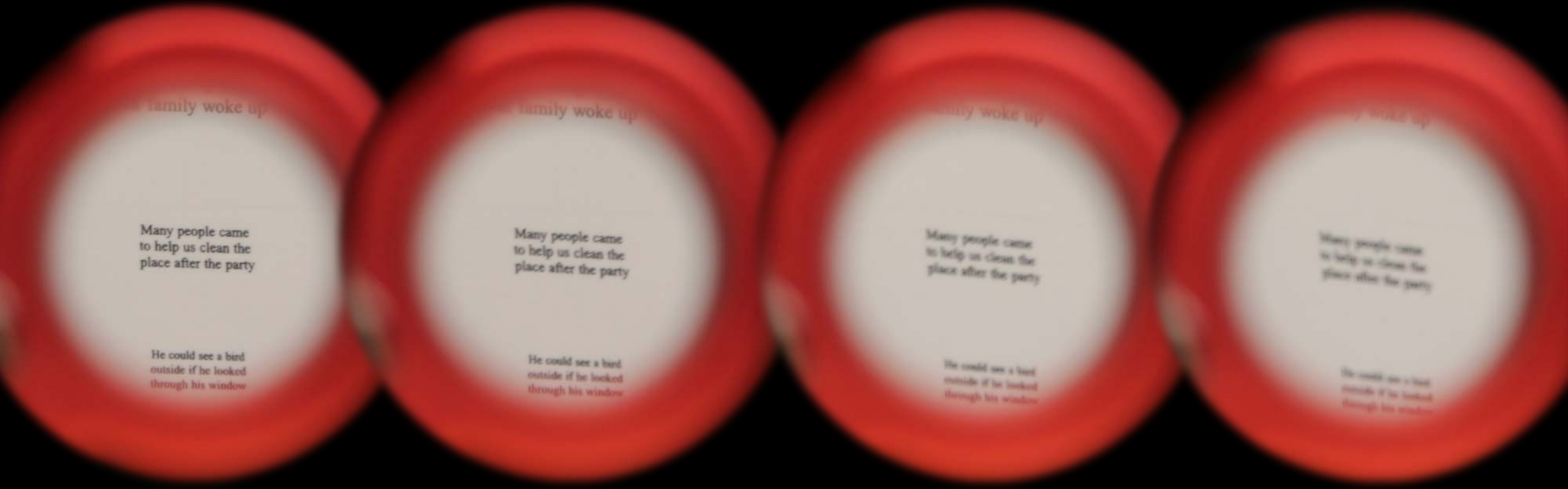
To assess the effect misalignment has on Uncorrected Distance Visual Acuity (UDVA) for two monofocal IOLs

Background

Toric IOL Misalignment

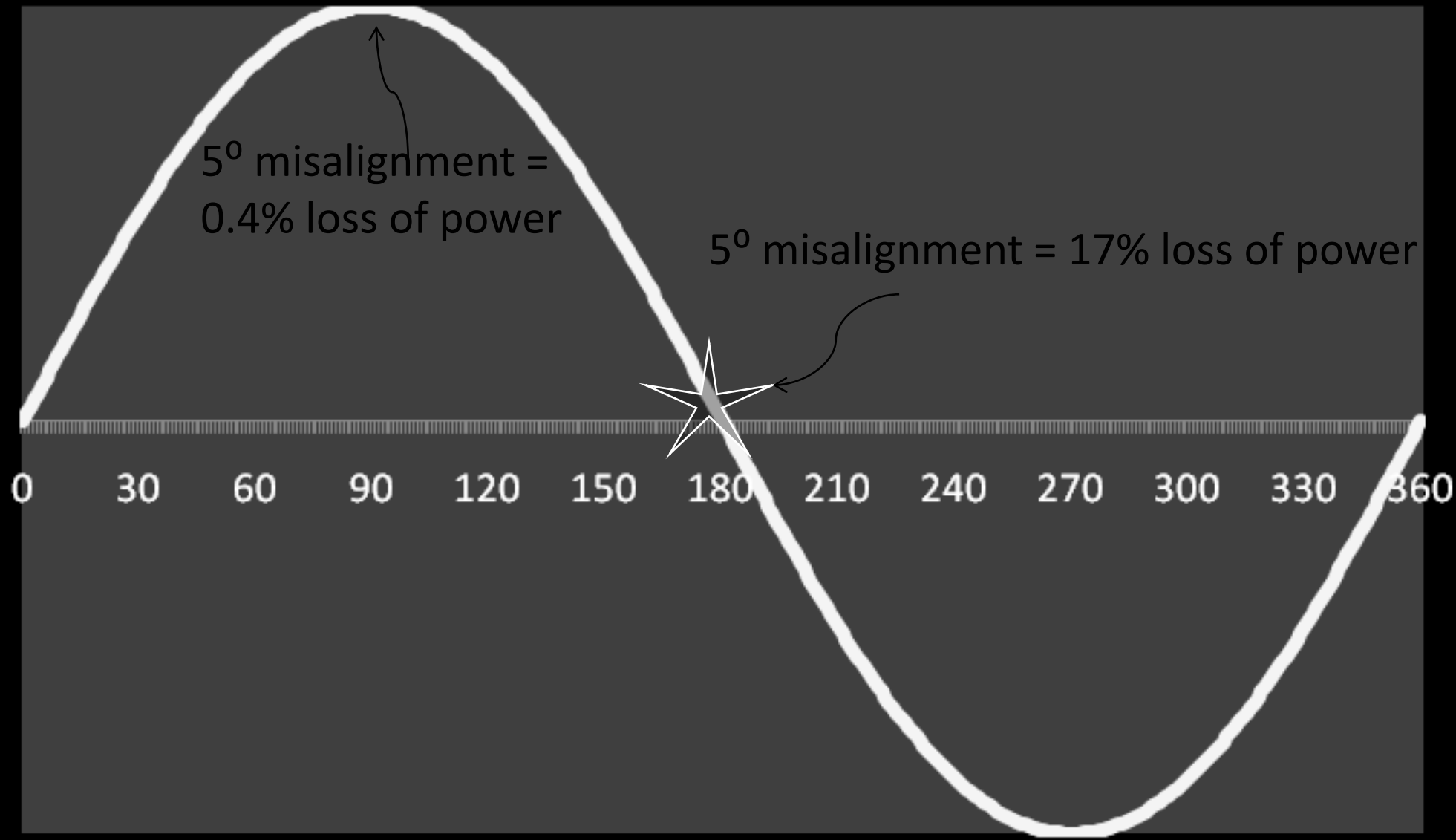


Toric Misalignment of T9



0° 5° 10° 15°

Math Frowns on Misalignment



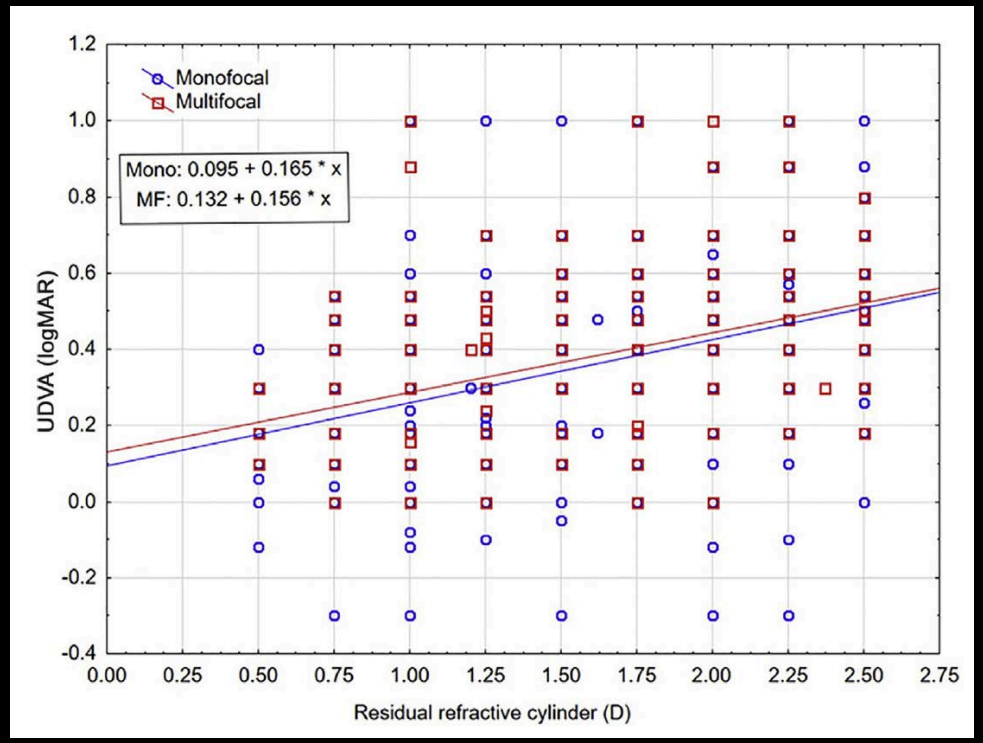
IOL Misalignment

Misalignment	% Loss	Absolute Loss	
		T3 (1.03D)	T9 (4.11D)
0deg	0%	0D	0D
5deg	17.5%	0.18D	0.71D
10deg	35%	0.36D	1.43D
15deg	50%	0.51D	2.05
30deg	100%	1.03D	4.11D

What about visual acuity?

Effect of astigmatism on visual acuity after multifocal versus monofocal intraocular lens implantation

John P. Berdahl, MD, David R. Hardten, MD, Brent A. Kramer, MD, Richard Potvin, OD



0.25D of residual cyl

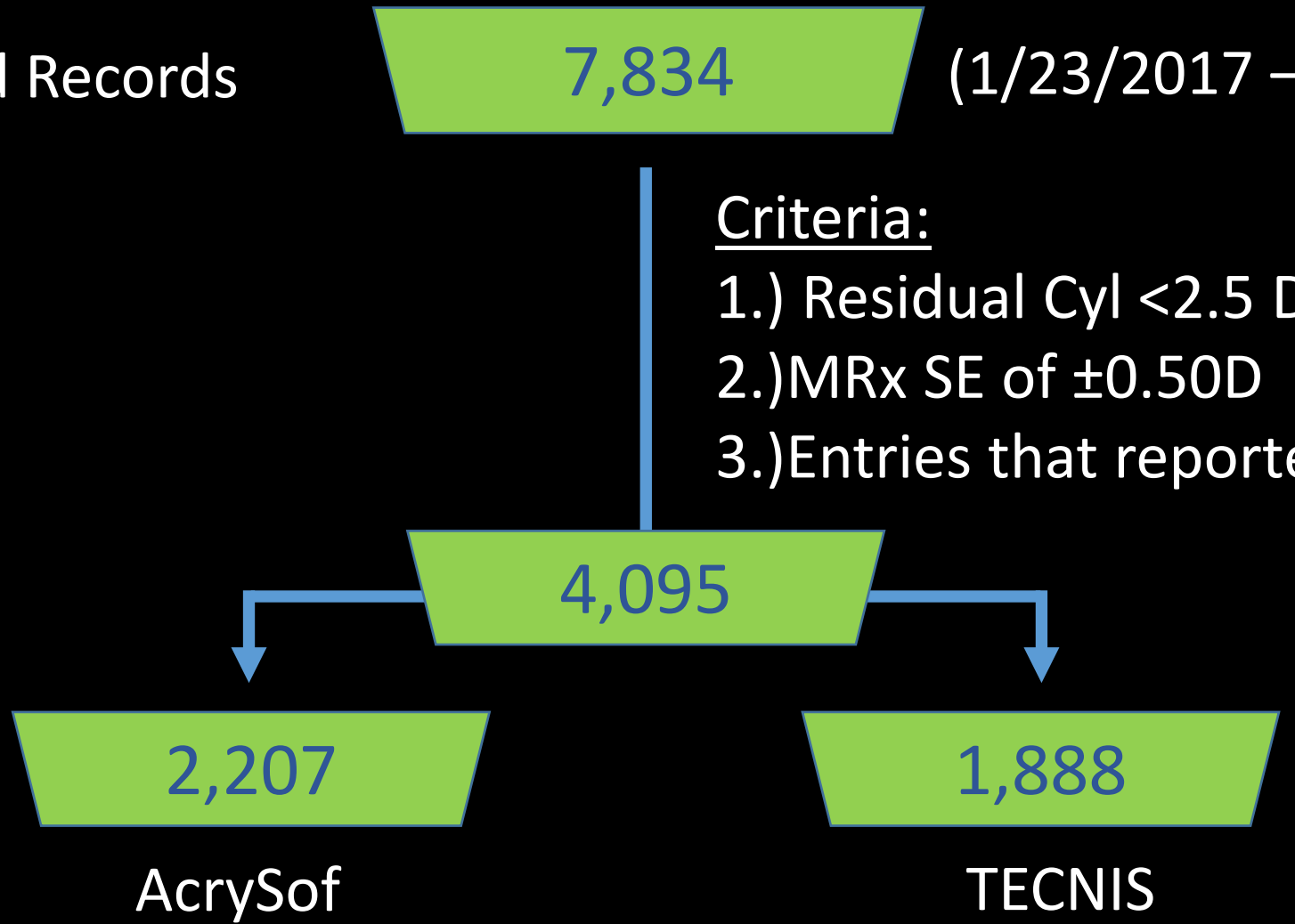
=

~1/2 line of vision

Methods

astigmatismfix.com: cleaning the data

Validated Records 7,834 (1/23/2017 – 12/31/2019)



Results

Cumulative Data

Table 1: Uncorrected Visual Acuity Misalignment Tolerance
AcrySof® IQ Monofocal Toric IOL

	Snellen; 20/x (n)							
Misalignment	SN6AT3	SN6AT4	SN6AT5	SN6AT6	SN6AT7	SN6AT8	SN6AT9	Total:
≥0° to <5°	36.7(43)	38.3(55)	38.6(52)	37.3(35)	40.3(17)	49.1(15)	55(11)	39.3(228)
≥5° to <10°	30.9(39)	35.2(53)	34.7(66)	35.8(47)	40.2(42)	41.6(15)	41.6(21)	36(283)
≥10° to <20°	35.9(107)	37.6(183)	39.7(189)	42.8(144)	46.2(72)	47(65)	51.9(53)	41(813)
≥20° to <30°	36.5(114)	44.4(137)	45.5(115)	55.5(68)	62.5(30)	57.3(7)		45.1(471)
≥30° to <40°	38.7(90)	44.9(57)	49.2(37)	87.1(4)				43.2(188)
≥40° to <50°	45.8(39)	58.2(27)	57.9(8)					51.3(74)
≥50° to <60°	50.4(29)	55.3(19)	58.9(4)					52.8(52)
≥60° to <70°	54.5(26)	59.6(6)	66(3)					56.3(35)
≥70° to <80°	48.9(19)	60.4(3)	147.4(3)					57.3(25)
≥80° to <90°	54.8(21)	78.3(3)						57.3(24)
90°	49.1(10)	63.2(4)						52.7(14)
Total:	39.5(537)	41.8(547)	41.7(477)	43.9(298)	46.4(161)	47.1(102)	49.5(85)	42.3(2207)

Abbreviations: IOL, intraocular lens
AcrySof® Toric Monofocal IOL (Alcon, Geneva, Switzerland)

Table 2: Uncorrected Visual Acuity Misalignment Tolerance
TECNIS® Monofocal Toric IOL

	Snellen; 20/x (n)							
Misalignment	ZCT150	ZCT225	ZCT300	ZCT400	ZCT450	ZCT525	ZCT600	Total
≥0° to <5°	35.7(22)	35.8(22)	41.8(34)	40.9(23)	43.1(16)	64.3(5)	44.1(7)	40.4(129)
≥5° to <10°	33.2(13)	36.7(37)	37(43)	37(30)	39.3(32)	38.5(15)	52(17)	38.3(187)
≥10° to <20°	37.9(70)	36.6(135)	42.2(175)	47.8(106)	50.6(105)	49.8(46)	54(34)	43.5(671)
≥20° to <30°	36.5(86)	41.8(138)	47.8(144)	53.2(71)	53.9(44)	94.5(7)		45.5(490)
≥30° to <40°	38.2(81)	47.5(83)	59.3(45)	102.3(9)				47.3(218)
≥40° to <50°	45.9(25)	52.6(35)	67(15)					52.8(75)
≥50° to <60°	50.2(28)	51.8(11)	52.6(4)					50.8(43)
≥60° to <70°	49.5(21)	84.1(5)						54.8(26)
≥70° to <80°	61.2(11)	56.1(14)						57.9(26)
≥80° to <90°	47.6(8)	60.1(6)						52.6(14)
90°	32.5(5)	56.5(3)						39.9(8)
Total:	39.9(370)	42.3(489)	45.5(461)	48.4(239)	48.6(197)	51.1(73)	52.1(58)	44.5(1887)

Abbreviations: IOL, intraocular lens
TECNIS® Toric Monofocal IOL (Johnson & Johnson, New Brunswick, NJ, USA)

Linear Regressions

Table 3: Linear Regression of Misalignment and UDVA
AcrySof® IQ Toric Monofocal IOL

	Linear Regression Slope* (loss of LogMAR UDVA per degree of rotation)	Coefficient of Determination** (R^2)	Misalignment to obtain 0.1 LogMAR	Misalignment to obtain 0.3 LogMAR
SN6AT3	0.0071	0.685	14.1°	42.2°
SN6AT4	0.0108	0.692	9.2°	27.5°
SN6AT5	0.0142	0.708	7.0°	21.0°
SN6AT6	0.0209	0.808	4.8°	14.3°
SN6AT7	0.0241	0.787	4.1°	12.4°
SN6AT8	0.0268	0.806	3.7°	11.2°
SN6AT9	0.0299	0.804	3.3°	10.0°

***All linear regression coefficients were statistically significant (T-test; $p<0.0001$; 95%CI did not include 0).**
****Regression Analysis of all categories was statistically significant (ANOVA; F>F-statistic; $p<0.001$)**
AcrySof® Toric Monofocal IOL (Alcon, Geneva, Switzerland)

Abbreviations: IOL, intraocular lens; LogMAR, logarithm of minimal angle of resolution; UDVA, uncorrected distance visual acuity.

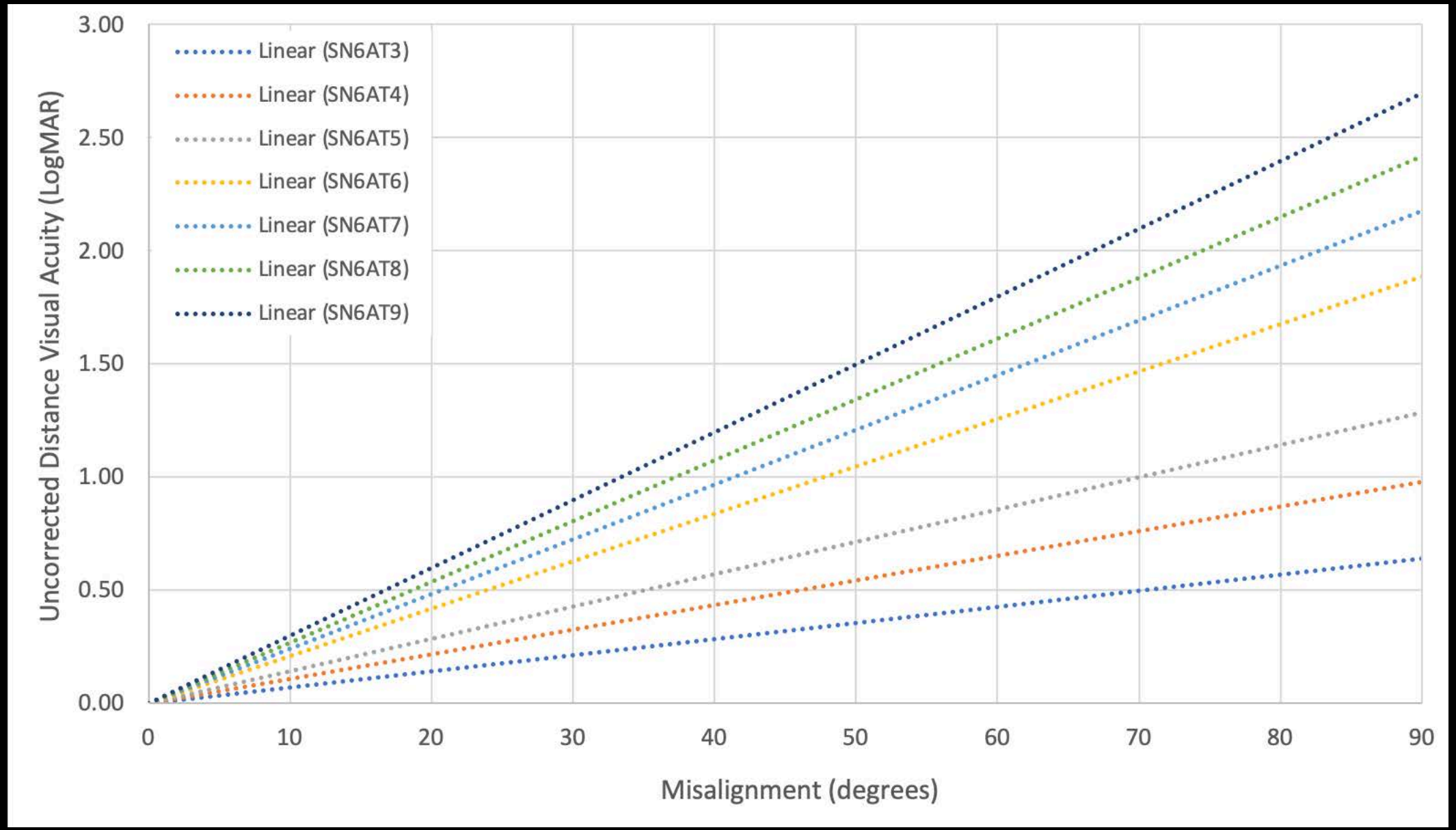
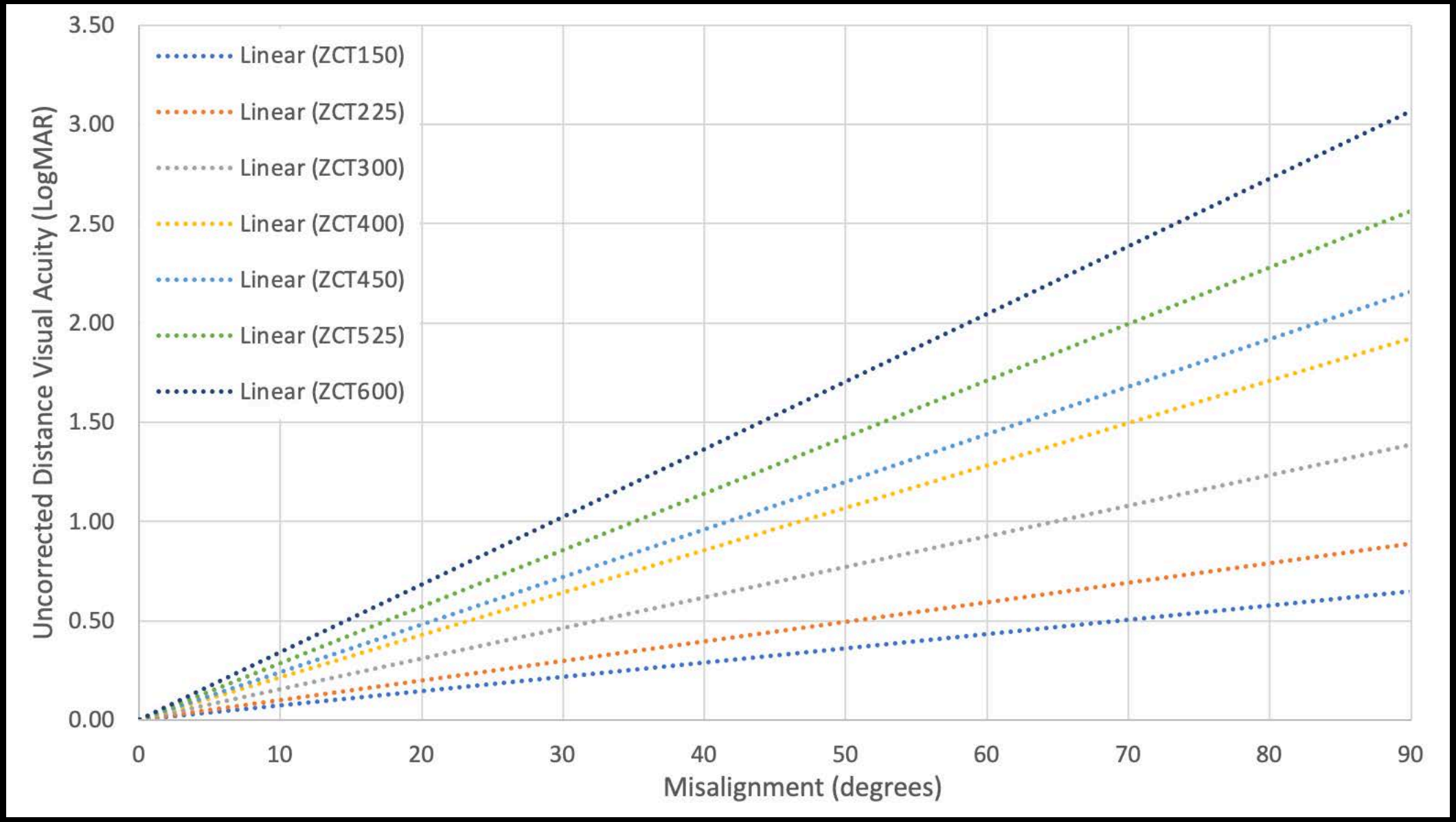

Linear (SN6AT3)
Linear (SN6AT4)
Linear (SN6AT5)
Linear (SN6AT6)
Linear (SN6AT7)
Linear (SN6AT8)
Linear (SN6AT9)
Uncorrected Distance Visual Acuity (LogMAR)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
10
20
30
40
50
60
70
80
90
Misalignment (degrees)

Table 4: Linear Regression of Misalignment and UDVA
TECNIS® Toric Monofocal IOL

	Linear Regression Slope* (loss of LogMAR UDVA per degree of rotation)	Coefficient of Determination** (R^2)	Misalignment to obtain 0.1 LogMAR	Misalignment to obtain 0.3 LogMAR
ZCT150	0.0072	0.687	13.9°	41.6°
ZCT225	0.0098	0.730	10.1°	30.4°
ZCT300	0.0154	0.751	6.5°	19.5°
ZCT400	0.0213	0.810	4.7°	14.0°
ZCT450	0.0239	0.796	4.2°	12.5°
ZCT525	0.0284	0.866	3.5°	10.5°
ZCT600	0.0341	0.819	2.9°	8.8°

***All linear regression coefficients were statistically significant (T-test; $p<0.001$; 95%CI did not include 0).**
****Regression Analysis of all categories was statistically significant (ANOVA; F>F-statistic; $p<0.001$)**
TECNIS® Toric Monofocal IOL (Johnson & Johnosn, New Brunswick, NJ, USA)

Abbreviations: IOL, intraocular lens; LogMAR, logarithm of minimal angle of resolution; UDVA, uncorrected distance visual acuity.


Linear (ZCT150)
Linear (ZCT225)
Linear (ZCT300)
Linear (ZCT400)
Linear (ZCT450)
Linear (ZCT525)
Linear (ZCT600)
Uncorrected Distance Visual Acuity (LogMAR)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
10
20
30
40
50
60
70
80
90
Misalignment (degrees)

Comparing AcrySof and TECNIS

Table 5: Comparison of UDVA per toric IOL misalignment

SN6T3 v. ZCT150

	SN6T3		ZCT150		
Misalignment	UDVA (LogMAR)	UDVA (Snellen; 20/x)	UDVA (LogMAR)	UDVA (Snellen; 20/x)	p-value (ANOVA)
≥05° to <10°	0.19	30.9	0.22	33.2	0.55
≥10° to <20°	0.25	35.9	0.28	37.9	0.33
≥20° to <30°	0.26	36.7	0.26	36.5	0.93
≥30° to <40°	0.29	38.7	0.28	38.2	0.76
≥40° to <50°	0.36	45.8	0.36	45.9	0.99
≥50° to <60°	0.40	50.4	0.40	50.2	0.97
≥60° to <70°	0.44	54.5	0.39	49.5	0.35
≥70° to <80°	0.39	48.9	0.49	61.2	0.27
≥80° to <90°	0.44	54.8	0.38	47.6	0.44
90°	0.39	49.1	0.21	32.5	0.02

Abbreviations: IOL, intraocular lens; UDVA, uncorrected distance visual acuity; LogMAR, logarithm of minimal angle of resolution; ANOVA, analysis of variance

SN6T3: AcrySof® Toric Monofocal IOL (Alcon, Geneva, Switzerland)

ZCT150: TECNIS® Toric Monofocal IOL (Johnson & Johnson, New Brunswick, NJ, USA)

Table 6: Comparison of UDVA per toric IOL misalignment

SN6T4 v. ZCT225

	SN6T4		ZCT225		
Misalignment	UDVA (LogMAR)	UDVA (Snellen; 20/x)	UDVA (LogMAR)	UDVA (Snellen; 20/x)	p-value (ANOVA)
≥05° to <10°	0.25	35.2	0.26	36.7	0.57
≥10° to <20°	0.27	37.6	0.26	36.6	0.44
≥20° to <30°	0.35	44.4	0.32	41.8	0.17
≥30° to <40°	0.35	44.9	0.38	47.5	0.43
≥40° to <50°	0.46	58.2	0.42	52.6	0.29
≥50° to <60°	0.44	55.3	0.41	51.8	0.81
≥60° to <70°	0.50	63.8	0.62	84.1	0.23
≥70° to <80°	0.48	60.4	0.45	56.1	0.82
≥80° to <90°	0.59	78.4	0.48	60.1	0.39
90°	0.50	63.2	0.45	56.5	0.82

Abbreviations: IOL, intraocular lens; UDVA, uncorrected distance visual acuity; LogMAR, logarithm of minimal angle of resolution; ANOVA, analysis of variance

SN6T4: AcrySof® Toric Monofocal IOL (Alcon, Geneva, Switzerland)

ZCT225: TECNIS® Toric Monofocal IOL (Johnson & Johnson, New Brunswick, NJ, USA)

Table 7: Comparison of UDVA per toric IOL misalignment

SN6T5 v. ZCT300

	SN6T5		ZCT300		
Misalignment	UCVA (LogMAR)	UCVA (Snellen; 20/x)	UCVA (LogMAR)	UCVA (Snellen; 20/x)	p-value (ANOVA)
≥05° to <10°	0.24	34.7	0.27	37.0	0.37
≥10° to <20°	0.30	39.7	0.32	42.2	0.13
≥20° to <30°	0.36	45.5	0.38	47.8	0.33
≥30° to <40°	0.39	49.2	0.47	59.3	0.11
≥40° to <50°	0.46	57.9	0.53	67.0	0.60
≥50° to <60°	0.47	58.9	0.42	52.6	0.74
≥60° to <70°	0.52	66.0	n/a	n/a	n/a
≥70° to <80°	0.87	147.4	0.40	50.0	0.22
≥80° to <90°	n/a	n/a	n/a	n/a	n/a

Abbreviations: IOL, intraocular lens; UDVA, uncorrected distance visual acuity; LogMAR, logarithm of minimal angle of resolution; ANOVA, analysis of variance

SN6T5: AcrySof® Toric Monofocal IOL (Alcon, Geneva, Switzerland)

ZCT300: TECNIS® Toric Monofocal IOL (Johnson & Johnson, New Brunswick, NJ, USA)

Conclusions:

- Higher power torics have greater loss of VA per degree of misalignment

- No difference in misalignment tolerability between AcrySof and TECNIS monofocal toric IOLs

Thank You!

Questions?

BrentKramerMD@gmail.com