The IOLMaster and determining toric IOL Power

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Abstract

Purpose: The power and axis of corneal astigmatism play an important role in the implantation of toric IOLs. For toric IOL calculation, preference among US surgeons is divided almost evenly among the IOLMaster, manual keratometry, and corneal topography.

Methods: An extensive literature search was conducted using PubMed and the ISI Web of Science to identify papers published since 2006 reporting outcomes of toric IOL implantation.

Results: A total of 28 papers were identified. Of these papers, 17 used the IOLMaster exclusively. The mean reported reduction in astigmatism for studies using the IOLMaster to measure the cornea was 74% compared with 72% in studies using other methods.

Conclusions: The IOLMaster has been used extensively in peer-reviewed, published studies of toric IOLs. The reported clinical outcomes for the IOLMaster exceed, or are at least as good as, those using manual or automated keratometry.

Determining Spherical IOL Power

Before the introduction of biometry using partial coherence interferometry (PCI), ultrasound measurements were considered the gold standard for axial length and anterior chamber depth measurement.[1] In 2000, the PCI-based IOLMaster optical biometer was introduced.[2-4] With this device, the measurement process was not only fast, but the non-contact method reduced the risk of infection and increased patient comfort during measurements. Initial reports suggested that the IOLMaster had the same accuracy as immersion ultrasound systems.[3] Subsequently, refractive outcomes using the IOLMaster have been shown to be consistently superior to those based on ultrasound, either immersion or applanation.[5-8] The IOLMaster has now been in use for over a decade and achieves measurements for axial length, anterior chamber depth and corneal curvature with high precision and good resolution.[2, 4, 9, 10]

Consequently, measurement devices based on PCI with integrated keratometry are being used exclusively by many ophthalmologists to retrieve axial length and keratometry values and to calculate IOL power.[11] Indeed, the 2010 Survey of ASCRS members, reports that 81% of surgeons use the IOLMaster as their preferred method of axial length measurement for IOL calculations (www.analeyz.com).

Determining Cylindrical IOL Power

While only the mean corneal power is of significance in the IOL power calculation of spherical IOLs, the power and axis of the corneal astigmatism plays an additional important role in the implantation of toric IOLs. As such, surgeons are using automated keratometry more frequently than ever for the calculation of toric IOL power. As summarized in Table 1, evidence for this trend is provided by the 2010 Survey of ASCRS members, which reports that 32% of surgeons use the IOLMaster as their preferred method of keratometry for toric IOL calculations (www.analeyz.com). Around half of ESCRS surgeons state the IOLMaster is their preferred method.

While spherical IOL power calculations are generally performed on ultrasound or optical biometry devices such as the IOLMaster 500 using standard formulas, for toric IOL calculation manufacturers indicate the use of their own toric IOL calculation methodology, usually in the form of an online toric lens calculator. In the US, the most frequently used calculators are the AcrySof Toric IOL Web Based Calculators (reference http://www.acrysoftoriccalculator.com/). In contrast to spherical IOL power calculation, these calculators are concerned with the astigmatic component (i.e. cylinder and axis) of the IOL power only and rely on the surgeon's preferred standard formula for the spherical equivalent component of the toric IOL. It is plausible that the first choice of most surgeons for calculation of IOL spherical power (P-IOL) of their toric IOL is the IOLMaster given its wide range of formula options and comprehensive set of optimized lens constants. This is also supported by the 2010 ASCRS survey that shows that 71% of surgeons use the IOLMaster as the preferred method of keratometry for spherical IOL power calculation. (www.analeyz.com).

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Table 1. Results of the 2010 surveys of ASCRS members (source - www.analeyz.com)

2010 Survey of US ASCRS Members	Preferred Method of Keratometry			
	Spherical IOL calculation		Toric IOL calculation	
	N	%	N	%
Manual Keratometry	73	16%	138	32%
Automated Keratometry	30	7%	24	6%
IOLMaster	315	71%	139	32%
Lenstar LS 900	10	2%	7	2%
Corneal Topography/ Corneal Analyzer	18	4%	126	29%

For toric IOL calculation, preference among US surgeons is divided almost evenly among the IOLMaster, manual keratometry, and corneal topography. In Europe, around half of the surgeons prefer to use the IOLMaster for toric IOL calculation. Corneal topography accounts for 30% of preferences with manual keratometry preferred by only 9% of European surgeons.

Why do so many prefer the IOLMaster? The answer is contained in Table 2, which summarizes the excellent surgical outcomes for toric IOLs with keratometry data from the published literature using the IOLMaster. The surgical studies demonstrate outcomes with the IOLMaster that equal or surpass those with other methods.

Equivalence in IOL Outcomes from toric IOL studies comparing the IOLMASTER and other Techniques

An extensive literature search was conducted using PubMed and the ISI Web of Science to identify papers published since 2006 reporting outcomes of toric IOL implantation. Papers in languages other than English were excluded, as were those in journals without an ISI Impact Factor. Papers on multifocal toric IOLs, post-refractive surgery patients, and keratoconus patients were also excluded.

A total of 28 papers were identified and listed in Table 2. Of these papers, 17 used the IOLMaster exclusively. The remaining studies report using manual keratometry, automated keratometry and the Orbscan. Table 2 describes the main refractive outcomes, and when available, the preoperative refractive and corneal astigmatism, the refractive astigmatism at the last postoperative visit, and the misalignment of the lens at that visit. Wherever possible, the reduction in astigmatism was calculated using the refractive astigmatism at the last postoperative visit and the preoperative refractive astigmatism. If the authors had calculated this, their value was used.

There are many variables associated with the studies including IOL type (although most use the AcrySof), degree of astigmatism, and sample size. Thus a rigorous analysis of success rates was not performed. Nonetheless, some comparison is appropriate. The mean reported reduction in astigmatism for studies using the IOLMaster to measure the cornea was 74% compared with 72% in studies using other methods. Note that the publication reporting the results of the initial AcrySof study reported a reduction in astigmatism of 57–65% using manual keratometry[39]. Five of the IOLMaster studies reported reductions in astigmatism above 80%. None of the studies using other methods reported reductions as high as 80%.

The outcomes of these studies were dependent on the correct alignment of the toric IOL. This is a product of the surgeons' skill and the stability of the IOL. For every 3 degrees of misalignment, around 10% of the planned astigmatic correction is lost. It is thus not surprising that two of the poorest outcomes (58% reduction in astigmatism) occurred in studies with the largest mean misalignment: 12.5 and 8.9 degrees [Jin et al. (2010)[16]; Koshy et al. (2010)[17]].

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Table 2. Studies reporting refractive outcomes for toric IOLs.

Author	Country	N	IOL	Pre-Op Cyl: Rx	Pre-Op Cyl: Ks	Post-Op Cyl: Rx	Rotation (Deg)	Reduction in Astigmatism
IOLMaster								
Bauer et al. (2008)[18]	NL	53	AcrySof SN60T3-5	2.21 ± 1.10	2.31 ± 0.72	0.27 ± 0.24	3.5 ± 1.9	88%
Mendicute et al. (2008)[19]	ES	30	AcrySof SN60T3-5	2.34 ± 1.28	2.35	0.72 ± 0.43	3.6 ± 3. 1	69%
Dardzhikova et al. (2009)[20]	CA	111	AcrySof SN60T3-5	1.25 ± 0.87	1.63 ± 0.67	0.32 ± 0.38	95% ≤ 10	74%
Mendicute et al. (2009)[21]	ES	20	AcrySof SN60T3-5	1.75 ± 0.71	1.90	0.62 ± 0.46	3.5 ± 2.0	65%
Ahmed et al. (2010)[22]	CA	234	AcrySof SN60T3-5		1.7 ± 0.4	0.4 ± 0.4	2 ± 2	76%*
Alio et al. (2010)[23]	ES	21	Acri. Comfort	4.46 ± 2.23	3.73 ± 1.79	0.45 ± 0.63		90%
Jin et al. (2010)[16]	DE	19	Various	3.76 ± 1.66	2.91 ± 1.63	1.59 ± 1.02	12.5 ± 6.7	58%
Koshy et al. (2010)[17]	UK	30	AcrySof SN60T3-5	2.00	1.97 ± 0.58	0.84 ± 0.41	8.9 ± 8.2	58%
Mingo-Botin et al. (2010)[24]	SP	20	AcrySof	1.89 ± 0.57	1.73 ± 0.59	0.61 ±0.41	3.7 ± 3.0	68%
Statham et al. (2010)[25]	AUS	12	AcrySof SN60T3	0.87	1.06	0.33		62%
Alio et al. (2011)[26]	SP	27	AcrySof SN60T3-7	2.87 ± 0.78	2.20 ± 0.71	0.94 ± 0.40	0 to 10	67%
Hoffmann et al. (2011)[27]	DE	40	AcrySof SN60T6-9	3.81 ± 1.18	3.55 ± 0.73	0.67 ± 0.32	2	82%
Park et al. (2011)[28]	SK	15	AcrySof SN60T3-5	1.94 ± 0.56		0.57 ± 0.26	3.5 ± 2.8	71%
Poll et al. (2011)[29]	USA	77	AcrySof SN60T3-5		2.10 ± 0.72	0.42 ± 0.50		80%*
Tassignon et al. (2011)[31]	BE	52	Morcher 89A	2.69 ± 1.38	3.22 ± 1.36	0.43 ± 0.63		84%
Visser et al. (2011)[32]	NL, ES	67	AcrySof SN60T6-9	3.81 ± 1.18			3	79%
Visser et al. (2011)[33]	NL, ES	26	Acrysof SN60T3-9	3.05 ± 1.58	2.54 ± 1.56	0.46 ± 0.40	5.0 ± 2.1	85%

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Table 2. Studies reporting refractive outcomes for toric IOLs.

Author	Country	N	IOL	Pre-Op Cyl: Rx	Pre-Op Cyl: Ks	Post-Op Cyl: Rx	Rotation (Deg)	Reduction in Astigmatism
Auto-Keratometry								
De Silva et al. (2006)[35]	UK	21	MicroSil 6116TU	3.52 ± 1.11	3.08 ± 0.76	1.23 ± 0.90	5	65%
Chang et al. (2008)[37]	USA	100	AcrySof SN60T3-5	2.48	0.53		3.4 ± 3.4	79%
Entabi et al. (2011)[40]	UK	33	T-flex 623T	3.35 ± 1.20	2.94 ± 0.89	0.95 ± 0.66	3.4	72%
Ernest and Potvin (2011)[41]	USA	185	AcrySof SN60T3		1.08	0.31		71%*
Goggins et al. (2011)[43]	AUS	38	AcrySof SN60T3-5	2.26 ± 1.03	2.55 ± 1.16	0.97 ± 0.72	1 ± 2.3	57%
Chua et al. (2012)[44]	SING	24	AcrySof SN60T3-5		1.60 ± 0.27	0.52 ± 0.36	4.2 ± 4.3	68%
Manual								
Ruiz-Mesa et al (2009)[38]	ES	32	AcrySof SN60T3-5	2.46 ± 0.99	2.28	0.53 ± 0.30	0.9 ± 1.8	78%
Holland et al. (2010)[39]	USA	256	AcrySof SN60T3-5	3.35 ± 1.20		0.59	3.8	57–65%
Other								
Zuberbuhler et al. (2008)[36]	CH, UK	44	AcrySof SN60T3-5	3.35 ± 1.20	2.94 ± 0.89	0.95 ± 0.66	2.2 ± 2.2	79%
Pouyeh et al. (2011)[30]	USA	44+42	AcrySof SN60T3-5		2.40 ± 0.85	0.48 ± 1.2*		80%*
Gayton and Seabolt (2011)[42]	USA	230	AcrySof SN60T3-5	1.60 ± 1.20		0.40 ± 0.60		75%

Summary and conclusion

In summary, the IOLMaster has been used extensively as described in peer-reviewed, published studies of toric IOLs. The predominance of the IOLMaster speaks to its perceptions within the surgical community. The reported clinical outcomes for the IOLMaster exceed, or are at least as good as, those using manual or automated keratometry.

Given the above summarized data, why are more surgeons not using the IOLMaster keratometry for toric IOL calculations? Given the above summarized data, one would expect an increasing number or surgeons to switch in the future. Some authoritative sources advocate for manual keratometry, but little or no data are presented to support the need for its use. The surgical studies tabulated above demonstrate evidence-based outcomes with the IOLMaster that equal or surpass those with other methods.

A study to be published in the Journal of Cataract and Refractive Surgery this summer, demonstrates excellent agreement between the IOLMaster and manual keratometry. Any differences in cylinder power and axis were relatively small, less than the manufacturing tolerances for IOLs, and thus considered of marginal clinical relevance.
The IOLMaster also has superior repeatability.

Based on the summarized clinical outcomes in the published literature, measurements obtained with the IOLMaster should give results that match or exceed those for alternative approaches for toric lens power calculations.

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