Comparative analysis of efficacy between trifocal and bifocal diffractive intraocular lens implantation after cataract surgery or refractive lens exchange: a meta-analysis of randomized controlled trials

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**Purpose:** To compare the efficacy between trifocal and bifocal diffractive intraocular lens (IOL) implantation in presbyopic patients who underwent cataract surgery or refractive lens exchange

**Methods:** Through Pubmed, Medline, Embase, and Cochrane Controlled Trials Register, we searched potentially relevant articles published from 1990 to 2016. Distance, intermediate, and near visual acuities (VAs) and defocus curves were measured as primary outcomes. Spectacle dependence, postoperative refraction, higher-order aberrations (HOAs), and contrast sensitivity (CS) were measured as secondary outcomes. Effects were pooled using random-effects method. Relative risk (RR), mean difference (MD), and 95% confidence intervals (CI) were used to compare the parameters.

**Results:** Among the 124 studies, 5 randomized controlled trials were selected, with a total of 260 eyes of 130 subjects. The trifocal IOL showed better monocular uncorrected distance VA than the bifocal IOL (MD, -0.03 logMAR; 95% CI, -0.06 to 0.00; P=0.03). The proportion of patients who did not achieve binocular uncorrected intermediate VA of 0.1 logMAR was lower in the trifocal IOL (7.7%) than in the bifocal IOL (45.3%) (RR, 0.18; 95% CI, 0.04 to 0.75; P=0.02; Fig. 1). The trifocal IOL showed better binocular distance VA corrected with defocus levels of -1.0, -1.5, and -2.5 diopter (D) than the bifocal IOL (All P≤.001; Fig. 2). No significant differences were found between the two groups in monocular uncorrected intermediate and near VAs; monocular corrected distance, intermediate, and near VAs; and binocular distance, intermediate, and near VAs. Spectacle dependence was lower in the trifocal IOL (10.0%) than in the bifocal IOL (35.8%) (RR, 0.18; 95% CI, 0.04 to 0.75; P=0.02). Refractive cylinder was higher in the bifocal IOL than in the trifocal IOL (MD, 0.18; 95% CI, 0.07 to 0.28; P=0.001). Spherical equivalent, CS, and HOAs were not significantly different from each other.

**Conclusions:** The overall findings indicate that both bifocal and trifocal IOLs provide comparable distance and near VAs. Trifocal IOL implantation may provide better intermediate VA and greater spectacle independence.

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Fig. 1 Forest plot of the number of patients who did not achieve 0.1 logMAR

Fig. 2 Forest plot of binocular distance corrected defocus curves

**Commercial Relationships:** Chang Ho Yoon, In Soo Shin, Mee Kum Kim, None; Won Ryang Wee, None
Results: 28 eyes in the Envista group and 34 eyes in the Tecnis group were included. Postoperative BCVA and IOP were significantly different after 6 months but no significant differences between two IOL groups ($p=0.058$). In the Envista group, SE changes were smaller than those of the Tecnis group at postoperative 1, 3, and 6 months. Postoperative predicted refractive error (RE) at 6 months showed a narrow range in values in the Envista group while extreme values appeared in the Tecnis group. The relevance between predicted targets by IOL with different formula-SRL/T, Hoffer Q, and Haigis, and postoperative SE at 6 months in entire eyes were evaluated using Pearson’s correlation coefficients ($0.393, 0.416$, and $0.422$ with $p=0.002, p=0.001$, and $p=0.001$ respectively). Pearson’s correlation coefficients was the biggest with predicted targets by the Haigis formula in both the Envista and the Tecnis group ($0.798, p=0.001$, and $0.524, p=0.002$), while coefficient was greater in the Envista group.

Conclusions: Envista MX60 is an IOL with a higher glass transition temperature and greater haptic compression force than Tecnis ZCBB0. In this study, less fluctuation in postoperative SE and a narrower range of postoperative RE in the Envista group than in the Tecnis group imply more stability acquired with a stiffer IOL in PACG eyes. Moreover, the Haigis formula proved to be more effective in predicting postoperative refractive targets than the Hoffer Q formula in PACG, and showed the higher predictability of postoperative refractive targets in eyes with Envista IOL than Tecnis IOL.

Commercial Relationships: Chang Kyu Lee, None; Ji Hyoung Chey, None

Program Number: 1144 Poster Board Number: B0636
Presentation Time: 3:15 PM–5:00 PM

Evaluation of Centration and Its Effect on Visual Outcomes in Small-aperture IOL Patients

Ling Lin, Srividhya Vilupuru, AcuFocus Inc, Irvine, CA.

Purpose: Small-aperture intraocular lens and small-aperture corneal inlay (IC-8 IOL and KAMRA inlay, AcuFocus Inc., Irvine, CA) improve near vision in presbyopic patients by extending depth of focus via an optically similar small-aperture mask. The mask in IC-8 IOL (IC-8) is embedded in a colorless, hydrophobic acrylic, aspheric IOL. AcuTarget HD diagnostic instrument (ATHD, Visiometrics, Spain) which has been used to accurately measure centration of KAMRA inlay is applied to measure centration of IC-8. The purpose of this study was to evaluate ATHD measurement of IC-8 postoperative centration and its effect on visual performances.

Methods: In a post-market clinical evaluation, 114 patients were contralaterally implanted with IC-8 in one eye and a monofocal IOL in the other eye, and 9 patients were implanted with IC-8 bilaterally. Centration of IC-8 was measured with respect to the first Purkinje image (P1) and the pupil center (PC) by ATHD in a subgroup at one or multiple visits. Mean centration was calculated with averaged data across all visits ($n=49$ and $18$ for IC-8 position vs. P1 and PC, respectively).

Correlation between centration and best-corrected distance visual acuity (BCDVA), subjective visual symptoms and satisfaction was calculated with pooled data from individual visits ($n=89$ and $30$ for IC-8 position vs. P1 and PC, respectively).

Results: The mean ± SD (min, max) of average IC-8 position vs. P1 and PC were $230.1 ± 125.9$ (43, 575) μm and $159.0 ± 132.6$ (42, 496) μm, respectively. The mean ± SD (min, max) of change in IC-8 position vs. P1 and PC between visits were $96.1 ± 90.3$ (5, 389) μm and $145.8 ± 98.7$ (12, 334) μm, respectively. Linear regression showed no correlation between BCDVA and IC-8 position vs. P1 ($R^2=0.02, F(1,87)=1.39, p=0.2423$) or vs. PC ($R^2=0.05, F(1,28)=1.55, p=0.2234$). There were ten IC-8 position measurements over $400$ μm vs. P1 and five measurements over $300$ μm vs. PC; their corresponding BCDVA were all $20/25$ or better. Similarly, no correlation was found between centration and subjective visual symptoms or satisfaction.

Conclusions: The variation observed in IC-8 centration results could be from several sources including small amounts of potential postoperative movement of IOL and the centration measurement. Taking that into consideration, current results showed no effect of centration on visual or subjective outcomes in IC-8 implanted patients.

Commercial Relationships: Ling Lin, AcuFocus Inc (E); Srividhya Vilupuru, AcuFocus Inc (E)
Intraocular lens power determination for a new extended range of vision lens

**Purpose:** Intracocular lens (IOL) power calculations can be performed using one of several equations which vary in the number of preoperative factors considered and inherent empirical regression adjustments. For newer IOL designs, such as extended range of vision IOLs, the performance of these power equations is not well known. In this study, we wanted to evaluate power calculation for a new extended range of vision IOL using a purely statistical approach.

**Methods:** Retrospective analysis was performed on 6-month postoperative data from a multi-center (15 clinical sites), randomized, subject/evaluator masked clinical investigation on 299 subjects implanted bilaterally either with the TECNIS Symfony Extended Range of Vision (ERV) IOL (148 subjects) or the parent monofocal control IOL (151 subjects). Statistical stepwise regression of numerous preoperative factors was performed to identify contributing factors to the IOL power that would lead to emmetropia. Analysis was done for the ERV and monofocal groups independently and compared between IOL groups for similarity of trends. None of the available IOL power equations were used in this analysis to avoid any inherent bias or assumptions in the various IOL power calculation formulae.

**Results:** Axial length, mean keratometry, age, keratometric cylinder and anterior chamber depth were the variables statistically significantly associated with IOL power for the monofocal lens (p<0.05, r² = 0.93). Axial length, mean keratometry and age were the variables statistically significantly associated with IOL power for the ERV lens (p<0.05, r² = 0.88). Data fit using only parameters common to both IOL groups from the stepwise regression, yielded similar parameter estimates (Table 1). In addition, post-operative refractive error was similar for monofocal (mean ± SD: -0.37 ± 0.42 D) and ERV (-0.40 ± 0.39 D) IOL groups.

Table 1: Parameter estimates for IOL power for emmetropia
Parameter Syfomny Monofocal
Axial Length -3.13 -3.17
Mean K -1.11 -1.18
Age -0.02 0.01*
*Not statistically significant (p>0.05)

**Conclusions:** Relative contribution of preoperative factors to determine IOL power was similar between an extended range of vision lens and its parent monofocal IOL. Power calculation for the extended range of vision IOL can be performed in the same fashion as the parent monofocal lens.

**Commercial Relationships:** Stan Bentow, Abbott Medical Optics (E); Sanjeev Kasthurirangan, Abbott Medical Optics (E)

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Sustained accuracy improvement in intraocular lens power calculation with the application of quality control circle
lei lin, Pingjun Chang, Jialiu Xie, Fan Lu, Yun-e Zhao. School of Ophthalmology and Optometry, Wenzhou Medical University, Wenzhou, China.

**Purpose:** Non-optimized process of intraocular lens (IOL) power calculation may lead to inaccurate refractive outcome. Quality control circle (QCC), a process management tool, has never been used in the field of ophthalmology. This retrospective clinical study was performed to optimize the IOL power calculation process utilizing QCC and test its efficacy in improving the accuracy of IOL power calculation.

**Methods:** The retrospective data of 107 patients (155 eyes) who had cataract surgery between November 2013 and September 2014 were reviewed to analyze the reasons related with the inaccurate IOL power calculation depending on QCC. Based on these reasons, three main strategies were formulated to optimize the process of IOL power calculation as follows: (1) the biological measurement protocol was normalized using the average of repeated measurement and/or checking the results by different operators; (2) the IOL constant was optimized refer to the User Group for Laser Interference Biometry; (3) the ray-tracing method PhacoOptics was applied in patients with long axial length (AL ≥ 26mm). Then the optimized process was applied to another retrospective data of 92 patients (131 eyes) from March 2015 to January 2016 to verify the efficacy of QCC in improving the accuracy of IOL power calculation.

**Results:** In patients with normal AL (22mm ≤ AL < 26mm), the percentage of eyes with achieved refractive outcomes within 0.5 D significantly increased from 58.2% to 79.7% calculated by the Haigis formula and 58.2% to 86.1% by SRK/T formula after using the optimized process (Figure. 1). Although there were no statistically significant differences in patients with long axial length by the two formulas (p=0.726 and 0.866), the accuracy reached as high as 75% with the application of PhacoOptics, which was significantly higher than that using the other two formulas (p<0.001).

**Conclusions:** This study demonstrated that QCC optimized and standardized the process of IOL power calculation, thus improved the accuracy of IOL power calculation in patients underwent cataract surgery. QCC may be a promising tool in clinical evaluation and management of refractive surgery.

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Hill-RBF Calculator versus Holladay2 and SRK/T Formulas for Intraocular Lens Power Selection
Carrie Wright, Shruti Sudhakar, Hans Andrews, Tara L. O’Rourke, Ingrid U. Scott, Seth Pantanelli. Penn State Milton S. Hershey Medical Center, Hummelstown, PA.

**Purpose:** To compare the Hill-RBF calculator to the Holladay2 and SRK/T formulas with respect to predicting residual refractive error in eyes with normal axial lengths.

**Methods:** The study was approved by the local Institutional Review Board. This retrospective consecutive case series included 31 eyes with axial lengths 22.0-25.2 mm that underwent cataract surgery...
with intraocular lens (IOL) implantation by a single surgeon between March and July 2016 at an academic medical center. All eyes underwent preoperative biometry measurements with IOLMaster 700 and received Bausch & Lomb MX60 one-piece IOL implants. For each eye, residual refractive error was predicted preoperatively using Holladay2 and SRK/T formulas, as well as the Hill-RBF calculator, with a physician-optimized lens constant of 119.4. Refraction was performed one month postoperatively. The mean numerical error for each formula was calculated as the difference between the predicted and actual postoperative spherical equivalent refractive error.

**Results:** The mean numerical errors for the Holladay2, SRK/T, and Hill-RBF formulas were -0.07, -0.02, and 0.12, respectively (ANOVA p-value = <0.00003). Median numerical errors for the same three equations were 0.045, 0.035, and 0.16, respectively. Post-hoc pairwise comparisons of mean numerical error revealed that both the Holladay2 and SRK/T formulas performed better than the Hill-RBF formula for the tested dataset, but were equivalent to each other (p = 0.24). The proportion of patients with a postoperative refractive error within 0.5D of predicted was 87.1% for Holladay 2, 77.4% for SRK/T, and 77.4% for Hill-RBF formulas.

**Conclusions:** Postoperative refractive error was within 0.5 D of predicted in greater than 75% of eyes for each of the three formulas. With respect to the mean numerical error, both the Holladay2 and SRK/T formulas performed better than the Hill-RBF, but further investigation using larger datasets are warranted.

**Commercial Relationships:** Carrie Knight, None; Shruti Sudhakar, None; Hans Andrews, None; Tara L. O’Rourke, None; Ingrid U. Scott, None; Seth Pantanelli, None

**Program Number:** 1150 Poster Board Number: B0642 Presentation Time: 3:15 PM – 5:00 PM

**Outcomes of the Haigis-L formula for calculating intraocular lens power after myopic and hyperopic laser refractive surgery in a tertiary teaching hospital**

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**Purpose:** Reduced accuracy of intraocular lens (IOL) power calculation in eyes with previous corneal refractive surgery is a clinical challenge. Many studies report single surgeon outcomes, and there is limited data on outcomes of the Haigis-L hyperopic formula. In this study we report outcomes from a tertiary teaching hospital using the IOL Master Haigis-L formula in patients who have had previous myopic or hyperopic LASIK or PRK.

**Methods:** Retrospective case series of all patients with previous refractive surgery who had uneventful phacoemulsification surgery with IOL power calculation using the IOL Master Haigis-L formula at Moorfields Eye Hospital between January 2012 and April 2015. Exclusion criteria were complicated surgery, coexisting conditions potentially confounding the refraction, lack of information about myopic vs hyperopic surgery, and implantation of a multifocal or toric IOL. Statistical analysis: mean values were compared using the Student t test if normally distributed. The Fisher chi-square test was used to analyze proportions. P values were 2 sided with significance of less than 0.05.

**Results:** 63 eyes (44 patients) were analysed. Mean patient age was 63 ± 9.7 years. 58.2% had previous myopic laser surgery; 42.4% had axial lengths >25.0mm. 15 eyes (24%) had previous hyperopic laser. For myopic Haigis-L, the mean arithmetic prediction (MAPD) error was -0.58 D ± 1.46 and the mean absolute (MA) error was 1.2 D ± 1.01. For hyperopic Haigis-L, the MAPD error was 0.07 D ± 0.84 D and the MA error was 0.67 D ± 0.47. Predictability of being within ±0.50 D and ±1.00 D of target was 25.0% and 52.1% for myopic eyes, and 33.3% and 66.7 % for hyperopic eyes. Comparison to the average IOL power recommended by the ASCRS online calculator for myopic eyes showed a higher IOL power was selected.

**Conclusions:** The arithmetic prediction error for myopic Haigis-L in this study is larger than previously described, but close to that reported in eyes with axial length >25mm. Using the ASCRS IOL calculator in myopic laser eyes would give less myopic outcomes. The hyperopic Haigis-L algorithm demonstrated accuracy in predicting and achieving target outcomes.

**Commercial Relationships:** Valerie P. Saw; Claudia Da Costa Paula, None; Yusrah Shweikh, None; Rajesh Deshmukh, None; Marie Restori, None

**Program Number:** 1151 Poster Board Number: B0643 Presentation Time: 3:15 PM – 5:00 PM

**Comparison of 4 Methods of Toric IOL Cylinder Power Selection**

Tom D. Padrick,1 Nicole Fram2, Robin Vann3, Michael Breen3,1

1Advance Vision Care, Los Angeles, CA; 2Duke Eye Center, Durham, NC; 3Alcon Laboratories, Fort Worth, TX.

**Purpose:** There is a need to improve refractive outcomes in cataract surgery when using toric IOLs. The purpose of this work is to compare the theoretical predicted post-op cylinder to the actual manifest cylinder for 4 different methods used to select the cylinder power of a toric IOL.

**Methods:** This is a retrospective analysis of data from 106 eyes obtained in a prospective randomized study comparing the Alcon on-line toric calculator (2014 version) to the ORA Intraoperative Aberrometry system (ORA System (Alcon, Fort Worth, TX)). All eyes were implanted with the Alcon SN6AT(x) toric IOL suggested by ORA. Preoperative biometry was obtained using the LENSTAR LS900. Pre op cylinder ranged from 0.64D to 4.11D. Post op manifest refraction was obtained between 21 & 35 days by a masked observer. The residual cylinder from the post op refraction was compared to the predicted residual cylinder by each method for the toric cylinder power implanted. In this analysis, only the preop biometry and post op manifest refraction from the Intraoperative Aberrometry arm of the study was used to evaluate and compare cylinder prediction error (CPE) calculated using the Alcon on-line toric calculator, the Holladay toric calculator, the Barrett toric calculator and the ORA Intraoperative Aberrometry system. It was assumed that for each method the IOL axis was perfectly aligned with the cylinder axis predicted by the method. Errors that may have occurred because the method predicted incorrect axes could not be evaluated in a retrospective analysis.

**Results:** The cylinder prediction error (CPE) is defined as the post op manifest residual cylinder minus the formula predicted residual cylinder for the IOL implanted. We calculated and compared the Mean CPE, Median CPE, %CPE<=0.50D, %CPE<=1.0D and maximum cylinder CPE for each method. The table in Figure 1 list the results of this analysis. The ORA results were statistically better (p<0.05) in all cases except the Median Cyl PE compared to Barrett (p=0.051) and the %CPE<=0.50D compared to Holladay (p=0.39) and Barrett (p=0.17).

**Conclusions:** The use of ORA intraoperative aberrometry for selection of the toric IOL cylinder power improved the cylinder refractive outcomes for all 5 metrics used in this analysis.

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For short eyes, USB can be inaccurate and care should be taken to eliminate sources of measurement error. Even with the use of the Hoffer Q formula, a post-operative hypermetropic shift should be anticipated. This study supports the routine use of SRK/T with medium and long ALs derived from USB.

**Commercial Relationships:** Darshak S. Patel, None; Luca Iari, None

**Program Number:** 1153 Poster Board Number: B0645

**Presentation Time:** 3:15 PM–5:00 PM

**Intraocular lens power calculations in patients with an axial length greater than 25mm**

Mauricio Galvan, Sara Gonzalez, Roxana Saucedo, Cecilio Velasco, APEC, Mexico city, Mexico.
Variation of ACD in the early postoperative term was greater in eyes with NS-60YG compared those with SN60WF and ZCB00V.

Commercial Relationships: HIDETOSHI ISHIDA, None; Norihiro Mita, None; Eri Shibuya, None; MaI Kita, None; Aya Nakano, None; YukI Ukai, None; Ayako Okamoto, None; Naoko Shibata, None; Eri Kubo, None; Hiroshi Sasaki, None

Program Number: 1157 Poster Board Number: B0647
Presentation Time: 3:15 PM–5:00 PM
Deepak Sambhara, None; Hans Andrews, None; ShrutI Sudhakar, None; TaRa L. O’Rourke, None; Kevin Wolfford, None; Ingrid U. Scott, None; Seth Pantanelli, None.
1 Dept. of Ophthalmology, Penn State Hershey Eye Center, Hummelstown, PA; 2 Ophthalmology Department, VA Medical Center, Lebanon, PA.
Purpose: The effective power of a toric intraocular lens (IOL) is reduced by 3% for each degree of IOL misalignment. The purpose of the current study is to compare the refractive and visual acuity outcomes following cataract surgery with toric IOL implantation using manual ink markings versus the Callisto markerless system to define the axis for IOL alignment.
Methods: This retrospective study included consecutive patients without vision limiting ocular pathology who underwent cataract surgery with toric IOL implantation by a single surgeon at an academic medical center from July 2015 - October 2016. Keratometry was performed preoperatively with IOLMaster 5 or 700 (Carl Zeiss Meditec) on 25 eyes from 23 patients for whom the reference and target axes were marked manually with ink and 14 eyes from 12 patients for whom the target axis was defined with the Callisto markerless system. IOL selection was calculated using the Holladay 2 formula. An AcrySofToric (Alcon) IOL was implanted in all patients. Primary outcome measures included the numerical error (difference between predicted and actual spherical equivalents [SE]) and uncorrected distance visual acuity (UCVA), which were measured 1 month postoperatively.
Results: The mean numerical error was 0.46 ±0.60 D in the group whose reference and target axes were marked manually with ink compared to 0.179±0.20 D in the Callisto group (p = 0.13). While 32% of eyes with manual markings had an absolute numerical error of ≥0.5D, only 7% of eyes in the Callisto group had an absolute numerical error ≥0.5D (p=0.08). The proportion of eyes with an absolute numerical error of <0.5 D was 68% in the manual marking group compared to 93% in the Callisto group (p=0.08). With manual marking and Callisto, 56% and 57.1% of eyes, respectively, had an UCVA of 20/20 (p=0.89).
Conclusions: Results of the current study suggest a trend toward better refractive outcomes with the Callisto markerless system compared to manual ink markings. No difference in UCVA outcome was identified between the two groups. These findings warrant further investigation in prospective randomized studies with larger sample sizes.

Commercial Relationships: Deepak Sambhara, None; Hans Andrews, None; ShrutI Sudhakar, None; TaRa L. O’Rourke, None; Kevin Wolfford, None; Ingrid U. Scott, None; Seth Pantanelli, None

Program Number: 1156 Poster Board Number: B0648
Presentation Time: 3:15 PM–5:00 PM
Comparison of Manual Ink Markings to the Callisto Markerless System for Defining the Reference Axis in Anticipation of Toric IOL Implantation
Hans Andrews, Deepak Sambhara, ShrutI Sudhakar, Ingrid U. Scott, Seth Pantanelli. Penn State College of Medicine, Hershey, PA.
Purpose: For each degree of misalignment, the effective power of a toric intraocular lens (IOL) is reduced by 3%. The purpose of this study is to compare manual ink markings and the Callisto® markerless system (Carl Zeiss Meditech, Inc.) with regards to defining the reference axis for the alignment of toric IOLs.
Methods: This consecutive case series included all eyes that underwent cataract extraction by a single surgeon between January 7th and November 17th, 2016, and for which a toric IOL implantation or a limbal relaxing incision was performed. For each eye, a reference image was captured preoperatively using the IOLMaster 700. Just prior to surgery, with the patient upright, the limbus was hand marked with an ink pen at the 3 and 9 o’clock positions. In the operating room, registration with the previously captured reference image was performed. A screenshot was captured that showed both the manual markings and the digitally defined reference axis. Using a digital protractor, the difference between the manually defined reference axis and the Callisto defined reference axis was measured.
Results: Thirty-four eyes of twenty-four patients were included in the study. The average absolute difference between the Callisto defined reference axis and the manually defined reference axis was 2.87 ± 2.45 (SD) degrees (range 0.2 to 8.4 degrees). Ten eyes (28%) had less than 1 degree difference, 8 (23%) differed between 1 and 2 degrees, 11 (31%) between 2 and 5 degrees, and 6 (18%) differed by more than 5 degrees.
Conclusions: There is no universally accepted method for defining the correct reference axis prior to cataract surgery. However, it is plausible that digitally defined registration is more accurate than manual marking. For nearly one-fifth of the eyes in the current study, the difference between the two methods was more than 5 degrees, suggesting that use of a digitally defined reference axis could translate to significant improvement in the correction of astigmatism. Studies evaluating refractive outcomes that compare the two marking methods are needed to further evaluate the potential benefits of the Callisto system.

Commercial Relationships: Hans Andrews, None; Deepak Sambhara, None; ShrutI Sudhakar, None; Ingrid U. Scott, None; Seth Pantanelli, None

Program Number: 1157 Poster Board Number: B0649
Presentation Time: 3:15 PM–5:00 PM
Influence of pupil dynamics on near vision performance in eyes implanted with a diffractive multifocal intraocular lens
Miriam Alves Ferreira. Ophthalmology, School of Medicine of Ribeirão Preto - University of São Paulo, Ribeirão Preto, Brazil.
Purpose: To investigate the effect of pupil size and contraction on near vision performance in eyes treated with monovision or a diffractive apodized multifocal intraocular lens (mfIOL).
Methods: 33 patients (66 eyes) with formal indication for cataract surgery were included and randomly assigned to bilateral implant of ReSTOR SN6AD1 apodized diffractive multifocal IOL (Alcon Laboratories, Inc.) (mfIOL, n = 32 eyes); or monovision with SN60WF for emetropia on dominant eye (WF-F; n = 17 eyes) and -1.25 D on the other eye (WF-N, n = 17 eyes). Comprehensive ophthalmological examination including far and near best-corrected, and without correction, visual acuity (VA) were performed at baseline and one year after surgery. Defocus curve was evaluated one year after surgery.

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after surgery to determine the area-under-the-curve (d-AUC) as an index of near, intermediate and far visual recovery. Dynamic pupillary diameter was recorded using an automatic pupilmeter (ISCAN - AA-ETL-100H; ISCAN, Inc. Woburn, MA) under dimer background (1 cd/m² – ColorDome; Diagnosys LLC) and during a 200 ms flash of 30 cd/m².

**Results:** There was no significant difference between groups for far or near VA. 48 weeks after surgery. Mean ± SE near VA (logMAR) was mfIOL: 0.06±0.01 and WF-N: 0.10±0.02 (p>0.05); and far VA was mfIOL: 0.09 ± 0.03 and WF-F: 0.11 ± 0.03. As expected, defocus curves for mfIOL showed a 2-peek pattern, with d-AUC of 2.0 ± 1.3 logMAR.dpt, while for monovision, a single peek was found, with d-AUC of 4.67 ± 1.51 logMAR.dpt. No correlation was found between pupil size measured before the light stimulation or the amplitude of pupil contraction and near or far VA or d-AUC, but interestingly, pupil size during light exposure was significantly correlated with d-AUC (r=0.54; p=0.0117).

**Conclusions:** Eyes implanted with the SN6AD1 mfIOL or monovision achieve similar near and far visual acuity. These data indicate that the calculated area under the defocus curve might be an objective index to report near, intermediate and far visual acuity recovery, and found that this index can be associated with photopic pupil size.

**Commercial Relationships:** Miriam Alves Ferreira

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**ABSTRACT B0650**

**Presentation Time:** 3:15 PM–5:00 PM

**Program Number:** 1159

**Poster Board Number:** B0651

**Impact of Incomplete Intraocular Lens Unfolding on Induced Astigmatism with Real-time Intraoperative Aberrometry**

**Nathan J. Abraham**, Jonathan Solomon

Ophthalmology, Howard University Hospital, Washington, DC; 2Bowie Vision Institute, Bowie, MD.

**Purpose:** The development and surgical application of intraoperative aberrometry has proven to be a valuable tool for intraocular lens (IOL) calculation and refractive prediction. When using toric IOLs, the pseudophakic refraction is influenced by factors that contribute to instantaneous effective lens position (ELP), which may differ from the final post-operative refraction. The process of IOL positioning after lens insertion represents a source of erroneous calculations. We present a case-series of time-lapsed pseudophakic refractions, with the use of a novel real-time intraoperative aberrometer, to provide early guidelines to improve the precision and accuracy of pseudophakic refractions, and have identified a potential factor that may lead to measurement inaccuracies.

**Methods:** Fifteen patients were identified with preoperative biometry of less than 0.50 D of keratometric astigmatism. All patients underwent small-incision, on-axis near-clear corneal phacoemulsification with a 2.5mm keratome. Subsequently, an apheric aberrometry measurement verified the existence of ≤0.50 D of total ocular astigmatism. A single piece non-toric monofocal IOL was placed. Following removal of the ophthalmic viscosurgical device, the eye was reinflated with balance-salt solution to a intraocular pressure of 18 mm Hg and serial refractions were measured every 10 seconds with the Holos™ real-time intraoperative aberrometer (Clarity Medical).

**Results:** At 17.5°C, an average time (AT) from IOL loading to unfolded lens measurement was 210±17 seconds. The lapsed AT for the pseudophakic cylinder to reduce toward the non-lens refraction was 171±0.46s for nine eyes. The average cylindrical was 1.94 D±0.88 D. At 21°C, an AT from IOL loading to unfolded lens measurement was 167±15 seconds. The AT lapsed for the pseudophakic cylinder to reduce toward the non-lens refraction was 95±0.49s for six eyes. The average cylindrical was 1.54 D±0.64 D.

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all cases, the orientation of the steep meridian was orthogonal to the long axis of the IOL, indicating the optic was partially folded.

**Conclusions:** The rate of IOL unfolding is temperature sensitive and related to the length of time the lens is compressed prior to intracameral insertion. Both factors can impact pseudophakic intraoperative aberrometry. Care in assessing the state of the IOL is recommended to avoid inaccuracies, particularly when utilizing toric lenses.

**Commercial Relationships:** Nathan J. Abraham, None; Jonathan Solomon, Bowie Vision Institute (I)

**Program Number:** 1160 **Poster Board Number:** I

**Presentation Time:** 3:15 PM–5:00 PM

**Intraocular lens insertion during resident phacoemulsification cases: identification of intraoperative characteristics specific to lens choice**

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**Purpose:** Resident physicians training in ophthalmology utilize a variety of intraocular lenses across a minimum of 86 primary cases required for graduation. Supervising physicians would benefit from understanding the intraoperative characteristics of individual lenses, which would allow a precision approach to guidance for each.

**Methods:** To describe the duration and complications encountered during intraocular lens implantation of three models of intraocular lenses (Alcon MA50BM, SA60AT, SN60WF), 120 de-identified cataract surgery video recordings were obtained from a single surgeon and viewed using VLC media player 2.2.4. The “Jump to time (Previous frame) v2.1” VLC add-on was used to record the following time signatures: first incision, lens injector insertion, insertion/removal of tools, and procedure end-time. The type of lens used, the number of adjustments, and the occurrence of intraoperative complications were also recorded. Statistical methods used included one-way ANOVA and Poisson regression.

**Results:** Mean lens insertion duration was almost three times longer for the MA50BM (75.5s) versus the SA60AT (27.8s) or SN60WF (28.6s). These results were highly significant (\( p<0.001 \)). However, mean post-insertion adjustment times for the SA60AT (25.0s) and SN60WF (25.1s) were longer than the MA50BM (15.7s), a trend that demonstrated marginal significance (\( p=0.053 \)). No significant difference was appreciated in lens loading time, mean post-insertion adjustment tool use, or Sinskey hook use among intraocular lens types. Out of 117 completed cases, we noted three with lens ejection difficulties, and two with intraoperative capsule collapse and lens dislocation.

**Conclusions:** The MA50BM lens was associated with increased insertion time, while the SA60AT and SN60WF required a longer period for post-insertion adjustment, characteristics consistent with the MA50BM’s larger lens and stiffer haptics. Despite slight differences in structure and cartridges used for insertion, the latter two lenses demonstrated similar intraoperative characteristics throughout the study.

**Commercial Relationships:** Alan Shan, None; Guadalupe Villarreal, None; Allen O. Eghrari, None

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**Outcomes in Scleral Fixated Sutured Intraocular Lenses Using Gore-Tex Suture**


**Purpose:** Scleral fixated intra-ocular lenses (IOL) have been shown to be effective as a secondary lens. There have been concerns with high rates of suture erosion with the use prolene sutures. Many ophthalmic clinicians are now using Gore-Tex suture for scleral fixation due to increased tensile strength. Outcomes for this procedure have not been widely described. The purpose of this retrospective interventional case series study was to evaluate the outcomes using Gore-Tex sutured scleral secondary intraocular lenses.

**Methods:** A review was performed of surgical cases at the Bascom Palmer Eye Institute from August 2015 to October 2016. Cases were found using CPT code for Akreos AO60 lens (Bauch and Lomb). Inclusion criterion was the use of the lens fixated to the sclera with Gore-Tex suture as a secondary IOL. Primary outcome measures were indications for scleral IOL, visual acuity at last follow up, and complications.

**Results:** 21 eyes of 20 patients were identified for inclusion. Causes for secondary IOL surgery were dislocated IOL (38%), complicated cataract surgery (29%), subluxed IOL (24%), and dislocated or subluxed crystalline lens (10%). Mean logarithm of the minimum angle of resolution (LogMAR) visual acuity improved from 1.0±0.62 to 0.62.
(20/197 Snellen equivalent) preoperatively to 0.60±0.61 (20/87 Snellen equivalent) on last follow up. Mean follow up post-surgery was 5.6 months (range 0.2–12.9).

There were no intraoperative complications noted. Postoperative complications included corneal edema in three eyes (14.5%), ocular hypertension in two eyes (9.5%), hyptonus in two eyes (9.5%), macular edema two eyes (9.5%), lens tilt two eyes (9.5%), hyphema in two eyes (9.5%), vitreous hemorrhage in one eye (4.8%). There was one eye (4.8%) with an erosion of the Gore-Tex suture through the conjunctiva leading to a purulent scleritis. This occurred 6 months after the initial surgery and required removal of the IOL and the suture.

**Conclusions:** Scleral fixation of Akers AO60 lens with Gore-Tex suture as a secondary IOL was generally well tolerated and produced an improvement in visual acuity. There was one patient with a suture related infection which required removal of the IOL and the suture.

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**Short-term outcomes of sutured versus sutureless scleral fixated intraocular lenses**

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**Purpose:** To compare short-term visual and anatomical outcomes of two distinct techniques of scleral fixation of intraocular lenses (IOLs).

**Methods:** An interventional, retrospective, comparative case series of 15 eyes with aphakia after cataract extraction or trauma who had scleral-fixated IOL surgery from November 2015 to November 2016 was performed. All patients had surgery in a tertiary referral center in the Dominican Republic with at least 3 months of follow-up. The images were captured using an anterior segment optic coherence tomography (Visante, Carl Zeiss Meditec, Dublin, California, USA). Tilt and decentration measurements were performed with the Image J software. The 3 Point Region of Interest plug-in was used to delineate the anterior and posterior surfaces of the lens. The main outcome measures were the IOL decentration, tilting and the best-corrected visual acuity (BCVA).

**Results:** A total of 15 cases were analyzed with a mean follow-up of 12.6 ± 18.99 months. Decentration and inclination in the sutureless scleral fixated (n=11) and sutured scleral fixated (n=4) were (494 microns ± 710 vs. 328 microns ± 2.4, p = 0.514) and (2.9° ± 2.7 vs. 2.23° ± 2.5, p = 0.660), respectively. As for visual acuity, the sutureless scleral fixated group had a BCVA of 0.44 logMAR and the sutured scleral fixated group was 0.43 logMAR (p = 0.918). Complications were reported only in the sutureless scleral fixated IOL being cystoid macular edema the most common complication (n=3).

**Conclusions:** Our short-term results demonstrate that sutured fixated IOL had less position changes. Both sutured and sutureless techniques resulted in good visual outcomes.
macular edema (ME), epiretinal membrane formation (EM), retinal detachment (RD) and endophthalmitis.

**Results:** 97 cases of iris-sutured posterior chamber IOLs were analyzed. Mean age was 68 years old. Length of follow-up ranged from 1 month to 3.5 years with a mean follow-up of 11 months. The most common associated eye condition was uveitis-glaucoma-hyphema syndrome in 11/97 (11.3%). The most common predisposing risk factors necessitating an iris-fixated IOL were trauma 21/97 (21.6%), pseudoexfoliation syndrome 13/97 (13.4%) and high myopia in 8/97 (8.2%). 89 eyes had previous cataract surgery, 7/97 (7.2%) had prior pars plana vitrectomy (PPV), 7/97 (7.2%) had prior glaucoma surgery, 3/97 (3%) had prior desemet’s stripping automated endothelial keratoplasty (DSAEK) and 3/97 (3%) had prior penetrating keratoplasty (PK). 45/97 (46.3%) underwent concurrent PPV, 8/97 (8.2%) had combined DSAEK surgery and 1/97 (1%) had a trabeculectomy revision. Mean pre-op best corrected visual acuity (BCVA) was 20/60 (range 20/20 to LP). Mean post-op BCVA was 20/40 (range 20/20 to LP). The most common post-operative complications included IOL dislocation in 10/97 (10.3%), elevated IOP in 5/97 (5.1%), hyphema 2/97 (2%), ME in 2/97 (2%), EM formation in 2/97 (2%), corneal edema in 1/97 (1%) requiring DSAEK. Glaucoma developed in 4 eyes postoperatively, 3 of which were medically managed. There were no cases of postoperative RD or endophthalmitis.

**Conclusions:** Iris-fixated posterior chamber IOLs can be a good treatment option for eyes with inadequate capsular support. In our study it led to long-term stability of the IOLs in 89.7% with few complications.

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