

## Cataract Surgery with a Trifocal Intraocular Lens - Patient Outcomes and Satisfaction Levels

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### Abstract

**Aim:** To evaluate the quantitative and qualitative benefits of the AcrySof® IQ PanOptix® Presbyopia Correcting Intraocular Lens (IOL) in cataract extraction patients.

**Methods:** For this retrospective chart review, patients were examined at 1, 3 and 6 months after cataract extraction and IOL insertion. Examinations included uncorrected and best-corrected visual acuity (UCVA and BCVA), refractive error, degree of spectacle wear, and overall patient satisfaction.

**Results:** 215 eyes of 121 patients were examined. At 3 and 6 months, 93.9% and 95.6% of patients, respectively, had UCVA of 20/30 or better. Never or only sometimes use of distance spectacles was reported in 96.5% of patients at 3 months and 98.5% at 6 months; 92.1% and 94.0% reported never or only sometimes needing spectacles for near vision at 3 and 6 months, respectively. 99.1% and 98.5% of patients reported being very happy, happy, or somewhat happy at 3 and 6 months, respectively. These positive results correlate with the low postoperative degree of spherocylinder. The spherocylinder at 3 months was  $\pm 0.50$  D in 88.1% of eyes and 88.4% of eyes at 6 months. The cylinder was  $\pm 0.50$  D in 80.2% at 3 months and 76.4% at 6 months.

**Conclusion:** The PanOptix® IOL used for cataract surgery showed high patient satisfaction and a high probability of spectacle independence for distance and near vision. The postoperative refractive outcomes demonstrated a low spherocylinder and cylinder, primarily related to careful IOL measurements, advanced IOL formulas, and surgical technique.

**Keywords:** Cataract surgery; Intraocular lens; PanOptix®; Trifocal; Visual acuity

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### Introduction

The correction of presbyopia is the “holy grail” in refractive surgery. Individuals are spending more of their activities of daily living on near or intermediate tasks such as smart phones and computers. This has led to a greater desire to achieve the full range of vision without spectacles or contact lenses. Presbyopic Intraocular Lenses (IOLs) allow for the potential of spectacle and contact lens independence. These implants can be used at the time of a refractive lens exchange or cataract surgery. Patient satisfaction levels have been reported to be high [1-4]. As part of the informed consent process, ophthalmic surgeons need to educate patients of the option of a presbyopic IOL.

Since the earliest recorded operations around 600 BC [5], cataract surgery has evolved to become one of the most common and successful surgical procedures [6]. Many significant advances over the past several decades improved the safety and efficacy in restoring Visual Acuity (VA) in patients with cataracts. The first toric IOL was developed in the 1990s to address corneal astigmatism [7], and was followed by multifocal IOLs to significantly improve near as well as distance vision [8-11]. However, multifocal IOLs are associated with a higher likelihood than monofocal lenses of developing visual disturbances such as halos and glare [12]. Multifocal IOLs improve distance and near vision, but intermediate vision is often compromised [13,14]. A surgeon’s use of multifocal lenses generally results in increased “chair time” to counsel patients on the quality of vision, especially with respect to night vision, as well as the lack of satisfactory intermediate vision. Extended depth of focus implants were developed to provide distance and intermediate vision but have shown some limitations in near vision [15].

Trifocal IOLs were developed to improve near, intermediate, and distance vision to decrease dependency on glasses or contact lenses. Several studies have determined very good visual outcomes and high levels of patient satisfaction [16-21]. A meta-analysis of studies involving patients undergoing bilateral cataract and/or refractive lens exchange surgery (11 studies; N=787 eyes) found that trifocal IOLs provided significantly better monocular uncorrected near and intermediate VA compared to monofocal implants selected for distance VA [22]. Trifocal IOLs were also associated with superior intermediate VA to that of multifocal lenses, with comparable VA at distance and near [23-25].

The AcrySof® IQ PanOptix® IOL (Alcon Laboratories, Inc., Fort Worth, TX) was approved by Health Canada in 2017 for the visual correction of aphakia after removal of a cataractous lens in adult patients with and without presbyopia [26]. It is available in a diopter range of +6.0 to +30.0 D in 0.5 D increments and +31.0 to +34.0 D in 1.0 D increments and creates a +2.17 D intermediate and +3.25 D near add power. Toric cylinder power options include 1.50 D, 2.25 D, 3.00 D, and 3.75 D. The overall lens length is 13.0 mm, with an optic diameter of 6.0 mm, including a 4.5 mm central region, and 15 diffractive steps. These diffractive steps have 3 heights that provide

focal points at 40 cm, 60 cm, and 120 cm in addition to distance. The anterior surface is aspheric to compensate for the positive spherical aberration of the average human cornea, while the posterior surface is spherical. The non apodized lens provides 88% utilization of light energy, and its design increases pupil independence [27].

The objective of this retrospective study was to evaluate the outcomes of patients undergoing cataract extraction after surgical implantation of the PanOptix® lens with respect to VA, refraction, and patient satisfaction.

## Materials and Methods

This was a retrospective chart review of consecutive patients who underwent cataract extraction and insertion of the PanOptix® IOL from June 2018 to December 2019. All patients provided informed consent for this procedure and the collection and analysis of data were conducted in accordance with the principles of the Declaration of Helsinki.

Consultations, diagnostic imaging, and surgery were performed at the Bochner Eye Institute, Toronto, Ontario, Canada. The Institute has a surgical centre, which is an Independent Health Facility approved by the Ontario Ministry of Health. Conditions considered to be either an absolute or relative contraindication for the PanOptix® lens are listed in table 1.

- Significant ocular surface disease, including keratitis sicca, meibomitis, Salzmann's nodular degeneration, or epithelial basement membrane disease
- Keratoconus, pellucid marginal degeneration, or corneal scarring with irregular astigmatism on computerized topography
- Radial keratotomy secondary to a higher risk of glare and halos
- Fuchs corneal dystrophy because of the risk of progressive disease and resultant corneal edema.
- Pseudoexfoliation because of the risk of a zonular dialysis either at the time of surgery or late postoperatively.
- Macular problems, including epiretinal membrane, pseudomacular hole, age-related macular degeneration, myopic macular degeneration, Stargart's disease, and retinitis pigmentosa
- Advanced glaucoma, as identified by changes to the optic disc and a visual field defect
- Optic neuropathy as documented by pallor of the optic disc and a visual field defect
- Angle kappa of  $\geq 0.6$  mm
- Patients who drive for a living and/or commercial pilots
- Perfectionists or hypercritical individuals

**Table 1:** Contraindications at the Bochner Eye Institute for the PanOptix® lens.

Patient education and selection were important aspects to ensure a high level of patient satisfaction. Patients were counselled about expected outcomes for distance, intermediate, and near, limitations of the procedure, and potential complications. Candidates were selected who had reasonable expectations about their visual improvements through lens implantation. Patients were screened for personality traits that may decrease the chance of satisfaction. All patients completed a preoperative questionnaire, which included asking how they would rate their personality on a scale from easy-going to perfectionist. We did not recommend surgery in those who were perfectionists and hypercritical, as they are less likely to be satisfied even if they achieve an uncorrected VA (UCVA) of 20/20 or better.

Cataract surgery was performed by a single surgeon (RS). IOL measurements were obtained using a Lenstar LS 900 (Haag-Streit Diagnostics, Bern, Switzerland) with the Barrett formula. Corneal topography and angle kappa measurements were obtained with a

Nidek OPD scan III (INNOVA Medical Ophthalmics, Toronto, ON). In cases of irregular astigmatism, the OCULUS®Pentacam® (OCU LUS Optikgeräte GmbH, Wetzlar, Germany) was utilized to detect anterior and posterior elevation, as well as corneal thickness measurements. A toric implant was chosen in all patients who had  $\geq 0.70$  D of astigmatism. The Davis MD OneStep marker without ink (Mastel, Rapid City, SD) was utilized to mark the steep axis of the cornea. An INFINITI® Vision System with OZil® (Alcon Laboratories, Inc., Fort Worth, TX) was utilized for phacoemulsification in all cases. In cases of femtosecond laser surgery, the CATALYS® Precision Laser System (Johnson & Johnson Vision Care, Inc., Jacksonville, FL) was used to create an anterior capsulotomy centred on the line of sight, and fragmentation of the cataract. After removal of the cataract all implants were loaded by the surgeon. An effort was made to remove all of the viscoelastic from behind the implant using a bimanual irrigation and aspiration technique. In cases of toric implants, the lens was rotated to align with the corneal markings. An attempt was made to centre the optic on the line of sight by having the patient fixate on a red fixation light attached to the microscope (Illuminating Surgical Keratoscope, Mastel, Rapid City, SD) and nudging the optic of the lens. All patients received intracameral moxifloxacin.

Follow-up examinations were performed at Bochner at 1 day and 1 week postoperatively. Patients were then seen by their referring doctors at 1 month, 3 months and 6 months. UCVA and best-corrected (BC) VA, measurement of refractive error, the degree of spectacles wear, and overall satisfaction based on interview questions were recorded at 3 and 6 months postoperative. It is recognized that when patients are asked about postoperative satisfaction levels by their surgeon they may be more reluctant to express how they really feel compared to being asked by their primary eye doctor. Postoperative data collection was completed by the primary doctor and sent to the Bochner Eye Institute. If at any time there were any postoperative concerns then the patient was referred back to Bochner for examination and diagnostic imaging.

## Results

In total, 215 eyes (121 patients) were included in this analysis. At the time of the cataract surgery, the femtosecond laser was utilized in 143 eyes (at least 1 eye in 80 patients) and traditional in 72 eyes (at least 1 eye in 41 patients). The femtosecond laser was programmed to create an anterior capsulotomy that was centred over the line of sight. The implanted PanOptix® lens was toric in 92 eyes (42.8%) of 63 patients. In the data presented, there were no cases in which patients underwent laser vision correction (laser *in situ* keratomileusis (LASIK) or photorefractive keratectomy (PRK)) to further optimize vision.

Outcomes were found to be excellent among these patients (Table 2). At 3 months, binocular (i.e., at least 1 eye) UCVA of 20/25 or better was reported in 78.3% of patients (including 139 of 205 eyes), and 93.9% (178 of 205 eyes) had UCVA of 20/30 or better. At 6 months, 76.5% of patients (89 of 128 eyes) had UCVA of 20/25 or better and 95.6% (114 of 128 eyes) had UCVA of 20/30 or better.

At 3 months, 96.5% of patients (including 194 of 201 eyes) reported never or only sometime needing spectacles for distance and 92.1% (186 of 202 eyes) never or only sometimes require spectacles for near vision. Only 0.9% (1 eye) and 1.8% (2 eyes) of patients indicated they always needed spectacles for distance and near vision, respectively. Six-month results were similar; 98.5% and 94.0% of patients (123

Vision	3 months postoperative	6 months postoperative
BCVA	n=114 patients; n (%) <sup>a</sup>	n=67 patients; n (%) <sup>a</sup>
20/15–20/20	80 (70.2)	45 (67.2)
20/25	25 (21.9)	18 (26.9)
20/30	9 (7.9)	4 (6.0)
<20/30	0 (0)	0 (0)
UCVA	n=115 patients; n (%) <sup>a</sup>	n=68 patients; n (%) <sup>a</sup>
20/15–20/20	53 (46.1)	33 (48.5)
20/25	37 (32.2)	19 (27.9)
20/30	18 (15.7)	13 (19.1)
<20/30	7 (6.1)	3 (4.4)
Spectacles - distance vision	n=113 patients; n (%)	n=67 patients; n (%)
Never	105 (92.9)	63 <sup>b</sup> (94.0)
Sometimes	4 (3.5)	3 (4.5)
Usually	1 (0.9)	1 <sup>c</sup> (1.5)
Always	1 (0.9)	0
Not applicable	2 (1.8)	0
Spectacles - near vision	n=114 patients; n (%)	n=67 patients; n (%)
Never	75 (65.8)	43 (64.2)
Sometimes	30 (26.3)	20 (29.9)
Usually	5 (4.4)	3 (4.5)
Always	2 (1.8)	1 (1.5)
Not applicable	2 (1.8)	0
Overall satisfaction	n=117 patients; n (%)	n=68 patients; n (%)
Very happy	71 <sup>d</sup> (60.7)	42 <sup>e</sup> (61.8)
Happy	35 <sup>d</sup> (29.9)	17 <sup>e</sup> (25.0)
Somewhat happy	9 (7.7)	8 (11.8)
Unhappy	1 (0.9)	1 (1.5)
Not applicable	1 (0.9)	0

**Table 2:** Results of Bochner Eye Institute case review among patients with no previous history of ophthalmic surgery.  
<sup>a</sup> n (%) represent binocular VA; i.e., VA in at least 1 eye of the patient; <sup>b</sup> Includes 1 “never/sometimes” response; <sup>c</sup> includes 1 “usually/always” response; <sup>d</sup> includes 4 “very happy/happy” and 1 “very happy/somewhat happy” responses; <sup>e</sup> includes 3 “happy/somewhat happy” and 1 “happy/unhappy” responses; <sup>f</sup> Includes 5 “very happy/happy” and 1 “very happy/somewhat happy” responses; <sup>g</sup> Includes 2 “happy/somewhat happy” responses.

and 117, respectively, of 125 eyes) reported never or only sometimes needing spectacles for distance and near vision, respectively, while no patients reporting needing them for distance and 1.5% (3 of 125 eyes) always needed them for near vision.

Patient satisfaction was also high. At 3 months, 99.1% (116 of 117 patients for whom this information was available) reported that they were very happy, happy, or somewhat happy, with their visual outcomes, and 1 patient (0.9%) was unhappy. The percentage of very happy, happy, and somewhat happy patients at 6 months was 98.5% (67 of 68 patients for whom this information was available) who were very happy, happy, or somewhat happy and 1 patient (1.5%) was unhappy.

At 3 months, the cylinder was between 0 and ±0.50 D in 80.2% of eyes (162 of 202), 14.9% (30 of 202) were between >±0.50 D and ±1.0 D, and 5.0% (10 of 202) were at >±1.0. At 6 months, 76.4% of eyes (97 of 127) were between 0 and ±0.50 D, 18.9% (24 of 127) were between >±0.50 D and ±1.0 D, and 4.7% (6 of 127) were at >±1.0. The spheroequivalent at 3 months was between 0 and ±0.50 D in 88.1% of eyes (178 of 202), between >±0.50 D and ±1.0 D in 10.4% (21 of 202), and at >±1.0 in 1.5% (3 of 202). The 6-month spheroequivalent was between 0 and ±0.50 D in 88.4% (114 of 129) and between >±0.50 D and ±1.0 D in 11.6% (15 of 129); no patients had a spheroequivalent at 6 months above ±1.0 D.

## Discussion

The high levels of patient satisfaction and spectacle independence found in this patient population are consistent with similar clinic-based assessments of objective and subjective patient data reported with the PanOptix® lens [3,28,29]. The high satisfaction levels in this study of 99.1% of patients at 3 months and 98.5% at 6 months are related to achievement of the full range of uncorrected vision with excellent quality. The low postoperative spheroequivalent and cylinder were important factors for satisfaction. There was a low incidence of any significant glare and halos, as no patients reported any serious difficulty with night driving at 3 and 6 months.

Patient selection for presbyopic IOLs is critical in order to achieve the best outcomes. A number of preoperative conditions that were considered relative contraindications allowed for excellent outcomes in this study. In this study group, patients were excluded who had prior refractive surgery such as LASIK or PRK. Although patients with prior LASIK and PRK can do well with a presbyopic IOL if they achieved good quality of vision after their initial surgery, these cases were not included in this report and are intended for a future paper. This group of prior laser vision correction patients has been reported by others as achieving satisfactory outcomes following presbyopic IOL implantation but with a higher incidence of a residual refractive error both sphere and cylinder. In an analysis of outcomes among post-LASIK patients, 95% experienced 20/25 or better VA with correction and 85% maintained at 20/25 or better at 1 to 3 months [30]. According to the subjective survey of this population, 68% of patients reported no or only mild halos, 79% had no need for spectacle use, and 86% indicated a satisfaction level of ≥8 out of 10. Another study of implantation of a trifocal IOL in 13 patients within 20 years of LASIK provided good visual outcomes (mean uncorrected distance and near VA were 0.28±0.29 and 0.02±0.05, respectively), with a significant myopic shift in postoperative SE (-0.92±0.76 D) and significant difference between the mean targeted SE and postoperative manifest refractive SE [31].

Reading vision was very satisfactory in our group of patients. The PanOptix® lens is designed to be pupillary independent to allow reading in both bright light and dim light. The design of the implant has an intermediate focal point at 60 cm, which appears to be ideal for computer monitor use. Other trifocal implants including the FineVision® (PhysIOL SA, Liège, Belgium) and AT-LISA® (Carl Zeiss Meditec AG, Jena, Germany) IOLs have intermediate focal points at 80 cm. A residual refractive error can be managed by refractive surgery such as laser vision correction, rotation of a toric IOL, an IOL exchange, or a piggyback lens in sulcus.

Limitations to this study include those common to single-site studies [32]. Although follow-up patient examination was conducted by independent referring doctors, which severely reduces reporting bias, full 3- and 6-month data collection were incomplete in several patients. As well, the inclusion criteria for IOL implantation included a determination of potential patient satisfaction based on personality, which may have biased outcomes towards a more favourable outcome. However, this patient population represented sequential patients undergoing IOL implantation, and thus there was no selection bias post-procedure.

## Conclusion

The outcomes and patient satisfaction levels reported in this cataract study with the PanOptix® lens were very high. Satisfied

patients (99.1 % at 3 months and 98.5% at 6 months) results in minimizing postoperative chair time and allows for easier care for the surgeon and other eye care professionals. The high patient satisfaction level may be related to careful preoperative patient selection, advanced IOL measurements and formulas, and precise surgical technique. Quality of vision was shown to be excellent with the PanOptix® lens as there were no reported significant long-term complaints such as difficulty with night driving. The intermediate focal point at 60 cm was shown to be excellent in allowing computer reading distance and other activities. The high patient success suggests that surgeons should consider discussion of this presbyopic IOL with qualified prospective cataract patients as part of the informed consent process. Future advances in IOL calculations and measuring devices, especially of the posterior cornea, may further enhance our outcomes.

## Data Availability

Full data are available upon request from the authors.

## Conflicts of Interest

The authors have no proprietary or commercial interest in any materials discussed in this article.

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