AcrySof IQ PanOptix Intraocular Lens Versus Extended Depth of Focus Intraocular Lens and Trifocal Intraocular Lens: A Clinical Overview

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Abstract: AcrySof IQ PanOptix Model TFNT00 (Alcon Laboratories, Fort Worth, TX) is a 1-piece aspheric hydrophobic presbyopia-correcting intraocular lens (IOL) launched in 2015. Unlike traditional trifocal IOLs that usually have an intermediate focal point of 80 cm, the PanOptix IOL is designed to have an intermediate focal point of 60 cm (arms-length), a more natural and comfortable working distance to perform functional tasks on computers, laptops, mobiles, among others. The non-apodized PanOptix IOL uses the ENUhanced LIGHT ENergy (ENLIGHTEN; Alcon Laboratories, Fort Worth, TX) optical technology that provides high (88%) utilization of light energy, low dependence on pupil size in all lighting conditions, and a more comfortable near-to-intermediate range of vision than traditional trifocal IOLs. This review provides an overview of the clinical performance of the PanOptix IOL and discusses it in the context of other commercially available trifocal IOLs, FineVision Micro F (PhysIOL, Liege, Belgium), the AT LISA tri 839MP (Carl Zeiss Meditec AG, Jena, Germany) and the extended depth of focus IOL, TECNIS Symfony (Abbott Medical Optics, Santa Ana, CA). A literature search was performed in the PubMed database to identify studies that have assessed the visual and other clinical outcomes with the PanOptix IOL. In total, 12 studies were included in this review article. Overall, the clinical evidence suggests that in general good visual outcomes, along with a high degree of spectacle independence, are achieved in patients implanted with the PanOptix, FineVision, AT LISA and Symfony IOLs. However, every MIOL has its benefits and limitations, which along with patient’s needs and clinical conditions are important factors to consider while selecting an IOL to achieve best possible post-operative outcomes.

Key Words: new-generation, PanOptix, patient satisfaction, presbyopia-correcting IOL, spectacle independence

Cataract surgeries performed in recent times not only improve vision but also aim to enhance the patient’s quality of life (QoL). The intraocular lens (IOL) used for implantation during cataract surgery plays a pivotal role in achieving the desired visual outcomes after surgery.1 Modern day IOLs are available in a variety of materials, designs, and optic features which influence their visual performance, for example, blue light filtering, aspheric, toric, monofocal, multifocal, and accommodating IOLs.1

Monofocal IOLs, the most commonly used lenses for the correction of presbyopia in patients undergoing cataract surgery, have only one fixed sharp focus point (usually for distance vision).2 As a result, most patients require the aid of corrective glasses to accomplish near and intermediate tasks. Multifocal IOLs (MIOLs) are designed to allow unaided good vision across a range of distances by providing multiple foci simultaneously. Studies have shown that MIOLs are comparable to monofocal IOLs for distance vision but are more effective for near vision and provide greater spectacle independence.2–4 Based on the focality, MIOLs are classified as either bifocal (2 foci) or trifocal (3 foci).5

Trifocal IOLs provide improved intermediate vision over bifocal IOLs, a specific advantage since many day-to-day activities, such as the use of computers, laptops, and handheld devices like mobiles and tablets, require good intermediate vision in the range of 60 to 80 cm. Although MIOLs are more frequently associated with photic disturbances than monofocal IOLs, the trifocals IOLs have improved performance in photic phenomena than bifocal IOLs.6,7 More recently, extended depth of focus (EDOF) IOLs, a new class of IOLs have been introduced. The EDOF IOLs elongate a single focal point over a range of distance using diffractive optics, thus providing better intermediate performance than monofocal IOLs.

In addition to fast and complete visual rehabilitation after cataract surgery, a significant factor that drives patients’ expectations is the motivation to achieve spectacle independence consistent with changing lifestyle patterns and professional needs. Thus, the demand for MIOLs is expected to surge globally due to the large number of cataract surgeries (~26 million cataract surgeries performed in 2017); changing socioeconomic frameworks; improvements in healthcare sectors and expenditure; access to innovative, advanced IOLs; and due to the increased awareness.8
FineVision Micro F (PhysIOL, Liege, Belgium) and the AT LISA tri 839MP (Carl Zeiss Meditec AG, Jena, Germany) are the first trifocal IOLs that were introduced in the market in 2010 and 2012, respectively. The EDOF IOL TECNIS Symfony (Abbott Medical Optics, Santa Ana, CA) was launched in 2014. The AcrySof IQ PanOptix Model TFNT00 (Alcon Laboratories, Fort Worth, TX) is a presbyopia-correcting IOL first launched in Europe in 2015, that uses the ENHANCED LIGHT ENERGY (ENLIGHTEN; Alcon Laboratories, Fort Worth, TX) optical technology.

This article provides an overview of the optical characteristics and clinical performance of the AcrySof IQ PanOptix and discusses it in the context of the FineVision, AT LISA trifocal IOLs and the Symfony EDOF IOL.

**LITERATURE SEARCH METHODOLOGY**

A literature search was performed for PanOptix, each of the trifocal IOLs and EDOF IOL in the MEDLINE/PubMed database (cutoff date: August 10, 2018), to identify studies reporting visual performance in patients after implantation. Only English language articles were screened for relevance. In addition, we also performed a manual search for potential trials that might have been missed in the primary searches. The following key terms were used:

For PanOptix: PanOptix [All Fields] AND (“lenses, intraocular” [MeSH Terms]) OR (“lenses” [All Fields] AND “intraocular” [All Fields]) OR (“lenses” [All Fields] AND “lens” [All Fields]) OR (“intraocular” [All Fields] AND “lens” [All Fields]) OR (“intraocular lens” [All Fields]).

For Fine Vision: FineVision [All Fields] AND trifocal [All Fields]. For AT LISA tri 839MP: AT LISA [All Fields] AND (trifocal [All Fields] AND IOL [All Fields]). For Symfony: [(extended depth of focus) OR extended vision] AND Symfony; (extended depth of focus) AND Symfony; (extended range of vision) AND Symfony.

**ACRYSOF IQ PANOPTIX IOL MODEL TFNT00**

The PanOptix Model TFNT00 (henceforth referred as PanOptix) is an ultraviolet (UV) and blue light filtering, non-apodized, foldable presbyopia-correcting IOL. This single-piece IOL has a central biconvex optic, with an inner diffractive and an outer refractive zone, and is made of a hydrophobic material acrylate/methacrylate copolymer and has 2 open-loop haptics.9,10 The lens is 13.0 mm in diameter with a central optic of 6.0 mm and is available in a dioptr (D) range of +6.0 to +30.0 D (0.5 D increments) and +31.0 D to +34.0 D (1.0 D increments). The posterior lens surface is spherical, and the anterior surface is aspheric with a diffractive surface on the central 4.5 mm portion of the optic zone, and divides the incoming light to create an intermediate addition power of +2.17 D (60 cm) and a +3.25 D (40 cm) near add power (Table 1). The anterior surface is designed with negative spherical aberration to compensate for the positive spherical aberration of the average human cornea.

The PanOptix IOL is based on a quadrefocal (4 foci) design and uses a proprietary optical technology, ENLIGHTEN, to redistribute the focal point at 120 cm to the distance focal point for amplified performance. This results in 2-step heights that is equal to 2 add powers/2 focal points (plus distance from base curve; Fig. 1). Light is split to 3 foci (distance: ∞, intermediate at 60 cm, and near at 40 cm). The 4.5 mm non-apodized, diffractive zone allows high light utilization, transmitting 88% of light to the retina at a 3.0 mm pupil size, and provides optimized performance in a wide range of lighting conditions due to low dependence on the pupil size.9,10 This light energy is distributed 25% each for near and intermediate and 50% for distance vision.

**FINEVISION MICRO F**

The FineVision Micro F (henceforth referred as FineVision) is the first trifocal IOL that received the CE mark in 2010. It is a single-piece, 25% hydrophilic acrylic, UV and blue light filtering, fully diffractive trifocal IOL with an intended addition power of +1.75 D for intermediate vision and a maximum addition power of +3.5 D for near vision (Table 1), offering an intermediate and reading distance of ~80 cm and ~40 cm, respectively.11 The IOL creates trifocality by combining 2 diffractive profiles.12 In total, 86% of light energy is transmitted to the retina. The apodized IOL optic is designed to allocate 49% of the light energy to distance vision, 34% to near vision, and 17% to intermediate vision, at a 3.0 mm pupil aperture.12

**TABLE 1. Optical Features of the Trifocal and Extended Depth of Focus IOLs Discussed in the Current Article**

| IOL Characteristics          | AcrySof IQ PanOptix                  | FineVision Micro F | AT LISA tri 839MP | TECNIS Symfony |
|------------------------------|-------------------------------------|--------------------|-------------------|----------------|
| Optical design               | Diffractive-refractive hybrid       | Diffractive        | Diffractive       | Diffractive    |
| Optic type                   | Non-apodized                       | Apodized           | Non-apodized      | Non-apodized   |
| Addition (near/intermediate) | +3.25 D/+2.17 D                    | +3.50 D/+1.75 D    | +3.33 D/+1.66 D   | +/-1.75 D      |
| IOL size                     | 6.0 mm                              | 6.15 mm            | 6.0 mm            | 6.0 mm         |
| Diffractive zone             | 4.5 mm                              | 6.0 mm             | 6.0 mm            | ~4.9 mm        |
| Optic material               | Hydrophobic acrylate/methacrylate copolymer | 25% Hydrophilic acrylate | 25% Hydrophilic acrylate with hydrophobic surface properties | Hydrophobic acrylate |
| Spherical aberration         | −0.10 μm                            | −0.11 μm           | −0.18 μm          | −0.27 μm       |
| Refractive index             | 1.55                                | 1.46               | 1.46              | 1.47           |
| Range                        | 6.0 to +34.0 D                      | +10.0 to +35.0 D   | 0.0 to +32.0 D    | +5.0 to +34.0 D |
| Pupil dependence             | Independent                         | Independent        | Independent       | Independent    |
| Toric availability           | Yes                                 | Yes                | Yes               | Yes            |

D indicates dioptr; IOL, intraocular lens; UV, ultraviolet.

*All the 4 IOLs discussed also have toric model options available (AcrySof IQ PanOptix Toric IOL, FineVision Toric Pod FT, AT LISA tri toric 939MP, Symfony Toric lenses ZXT series) to correct for astigmatism. The toric IOLs are beyond the scope of the current article and hence not discussed.

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Another trifocal aspheric, diffractive IOL, FineVision HP (PhysIOL) is also available. This trifocal IOL is similar to the FineVision IOL but is made of hydrophobic material. It is a 1-piece, glistening-free lens available in the range of +10.0 to +35.0 D (0.5 D increments). This IOL was launched in 2017.

**AT LISA TRI 839MP**

The AT LISA tri 839MP (henceforth referred as AT LISA) is a single-piece, UV filtering, diffractive trifocal IOL with +3.33 D near addition and +1.66 D intermediate addition, offering a reading and intermediate distance of ~40 and ~80 cm, respectively (Table 1). It is composed of a hydrophilic-acrylic (25% water content) material with hydrophobic surface properties. Only the central area of 4.34-mm diameter functions like a trifocal, whereas the peripheral area is a bifocal optic. Across all pupil sizes, 85.7% of light energy is transmitted to the retina. The IOL has asymmetrical light distribution across 3 foci: 50% to distance, 20% to intermediate, and 30% to near vision. The lens received the CE mark in 2012.

**TECNIS SYMFONY MODEL ZXR00**

The Symfony ZXR00 lens (henceforth referred as Symfony) is a single-piece, biconvex, UV blocking hydrophobic-acrylic EDOF IOL with +1.75 D intermediate addition. This IOL has an achromatic diffractive surface that provides a low add foci which results in elongating the range of vision from distance through intermediate.

The achromatic surface aims to correct chromatic aberrations of the cornea. This lens has an overall diameter of 13.0 mm with an optic of 6.0 mm (Table 1). The lens received a CE mark in Europe in June 2014 and is the first EDOF-labeled IOL approved in the United States in 2016.

**LITERATURE SEARCH RESULTS**

For PanOptix the search identified 15 studies. Two optical bench performance studies were omitted as 1 was in German, and the other compared PanOptix versus a bifocal IOL. In all, 12 studies that evaluated the visual outcomes in patients who underwent bilateral implantation with PanOptix IOL were included (Table 2). However, the study comparing PanOptix with a
Table 2. Visual Outcomes Reported in Patients After Bilateral Implantation With PanOptix Trifocal IOL in Clinical Studies

| Author                          | Study Design (Follow-Up Period) | Surgery                          | IOL                                      | Patient (Eyes) | UDVA (logMAR) | CDVA (logMAR) | UIVA (logMAR) | CIVA (logMAR) | UNVA (logMAR) | CNVA (logMAR) |
|--------------------------------|---------------------------------|----------------------------------|------------------------------------------|----------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Escando´n-Garcı´a et al (2018)  | Prospective (39–50 d)          | Cataract                         | PanOptix                                 | 45 (90)        | 0.07 ± 0.00  | -0.07 ± 0.19  | —             | —             | —             | —             |
| Mencucci et al (2018)          | Nonrandomized, prospective (3 mo) | Cataract                         | PanOptix                                 | 60 (120)       | -0.02 ± 0.08 | -0.03 ± 0.05  | At 60 cm      | 0.07 ± 0.04* | 0.15 ± 0.05* | 0.12 ± 0.04*  |
| Ali´ et al (2018)              | Prospective, consecutive case series (6 mo) | Cataract                         | PanOptix                                 | 26 (52)        | 0.07 ± 0.10  | 0.08 ± 0.10   | At 60 cm      | 0.06 ± 0.05* | 0.18 ± 0.05* | 0.13 ± 0.04*  |
| Ruiz-Mesa et al (2018)         | Dual-arm, comparative, nonintervention (9–24 mo) | Cataract or RLE                  | PanOptix SYM | 34 (68)       | 0.00 ± 0.03  | 0.05 ± 0.12   | —             | —             | —             | —             |
| de Medeiros et al (2017)       | Prospective, nonrandomized, comparative (180 d) | Cataract                         | PanOptix                                 | 20 (40)        | 0.00 ± 0.07  | 0.05 ± 0.07   | At 60 cm      | 0.06 ± 0.10  | 0.05 ± 0.05  | —             | —             |
| Cochrane et al (2018)          | Prospective, randomized, comparative (6 mo) | Cataract                         | PanOptix                                 | 60 (120)       | 0.97 ± 0.139 | 0.96 ± 0.100  | —             | —             | 0.66 ± 0.00* | 0.64 ± 0.07*  |
| Kohnen et al (2017)            | Prospective, single-arm (3 mo)   | Cataract                         | PanOptix                                 | 27 (54)        | 0.00 ± 0.09  | -0.07 ± 0.06  | At 60 cm      | 0.01 ± 0.12  | 0.01 ± 0.07  | 0.03 ± 0.11  |
| Monaco et al (2017)            | Prospective randomized, double-blind, controlled (4 mo) | Cataract                         | PanOptix                                 | 60 (120)       | 0.00 ± 0.03  | 0.04 ± 0.07   | —             | —             | 0.02 ± 0.06 | 0.01 ± 0.04* |
| Guido and Pottin (2017)         | Double-arm comparative nonintervention (6–24 mo) | Cataract                         | PanOptix                                 | 60 (120)       | -0.05 ± 0.07 | 0.02 ± 0.06  | —             | —             | 0.07 ± 0.11  | 0.11 ± 0.08  |
| García-Pérez et al (2017)      | Prospective case series (1 mo)   | Cataract                         | PanOptix                                 | 58 (116)       | 0.03 ± 0.06  | 0.12 ± 0.18  | At 60 cm      | 0.02 ± 0.07  | 0.03 ± 0.09  | —             | —             |
| Lawless et al (2017)           | Retrospective consecutive case series (4–9 wk) | Cataract or RLE                  | PanOptix                                 | 33 (66)        | 0.01 ± 0.10  | 0.12 ± 0.12  | 0.13 ± 0.258  | 0.12 ± 0.14  | 0.11 ± 0.04  | —             | —             |
| Vilan et al (2017)             | Prospective, nonrandomized, comparative (1 mo) | Cataract                         | PanOptix Blended trifocal (Restor SYZ10 + SN6AD1) | 20 (40)       | 0.01 ± 0.06  | 0.04 ± 0.02  | —             | —             | -0.03 ± 0.12 | 0.07 ± 0.03  |

CDVA indicates corrected distance visual acuity; CIVA, distant corrected intermediate visual acuity; CNVA, distant corrected near visual acuity; DOF, extended depth of focus lens; IOL, intraocular lens; logMAR, logarithm of minimum angle of resolution; RLE, refractive lens exchange; SD, standard deviation; UDVA, uncorrected distance visual acuity; UIVA, uncorrected intermediate visual acuity; UNVA, uncorrected near visual acuity; VA, visual acuity.

*P < 0.05 vs comparator; VA is reported in mean ± SD. Unless specified the reported measurements are of binocular uncorrected and corrected distance visual acuity at 4 m (UDVA, CDVA) and uncorrected and corrected intermediate (60 cm), and uncorrected and corrected near (at 40 cm) VA.

†Ref Mencucci et al (2018). AT LISA was significantly better than Symfony and PanOptix at 80 cm; Symfony was significantly better than PanOptix at 80 cm; AT LISA and PanOptix were significantly better than Symfony for near vision (P < 0.05); no significant difference with AT LISA and PanOptix for near vision.

‡Decimal value reported.

§Ref Monaco et al (2017). PanOptix was significantly better than Symfony and monofocal IOL (P < 0.05); Symfony was significantly better compared to monofocal IOL (P < 0.05).
bifocal IOL is not discussed in the article. In addition, results of a PanOptix study that were presented at the ESCRS 2018 conference are also briefly discussed (not part of the literature search).27

Similarly, after screening, 14, 16, and 9 studies were identified for FineVision, AT LISA, and Symfony, respectively. A summary of key studies and clinical outcomes for these IOLs is provided in Tables 3 to 5, respectively.15,28–65

**OPTICAL BENCH CHARACTERISTICS OF PANOPTIX**

This section discusses the optical dynamics of PanOptix, trifocal, and the EDOF IOLs in an in vitro analysis. The clinical experience of patients with these IOLs is discussed separately.

Carson D et al (2016)66 compared the optical bench performance for PanOptix, FineVision, and AT LISA. Contrast sensitivity (CS) was evaluated with modulation transfer function (MTF) measurements in a spherical aberration matching cornea for 3.0 mm of aperture for 2 spatial frequencies: 50 line pairs per millimeter (lp/mm) and 100 lp/mm, equivalent to 20/40 and 20/20 Snellen visual acuity (VA), respectively. For PanOptix and each trifocal IOL, the MTF curve showed 3 mean peaks corresponding to distance, intermediate, and near foci. PanOptix had higher MTF values at both distance and intermediate foci than the other 2 trifocals, whereas the near focus values were highest for AT LISA.66 The image quality performance of PanOptix was comparable to AT LISA and FineVision IOLs at distance and near foci, but the image contrast at intermediate 60 cm focus was significantly better for PanOptix compared with both AT LISA and FineVision. This was expected because, by design, the intermediate focal point for both FineVision and AT LISA is around 80 cm. The badal images of the Early Treatment Diabetic Retinopathy Study chart also showed that PanOptix has a better image resolution at 60 cm than the 2 trifocal IOLs while providing a similar resolution at 80 cm. The 20/40 text line was resolvable with PanOptix from 80 cm to 40 cm. The best near focal point was 42 cm for PanOptix and 40 cm for the FineVision and AT LISA IOLs. The bench-measured intensity of background halos was relatively higher for AT LISA than the other 2 IOLs. Overall, these bench results demonstrated that PanOptix is equivalent to or shows a better optical performance than the trifocal IOLs for image quality, resolution, and photic phenomena.

An optical bench comparison for PanOptix and Symfony is not available in the literature. An in vitro optic bench comparison of the optical quality of the EDOF Symfony IOL with AT LISA and FineVision has been reported.67 Unlike trifocal IOLs, the MTF curve for Symfony showed only 2 peaks corresponding to intermediate and distant vision, consistent with bifocal design. Both the trifocal IOLs showed better optical quality at distance and near vision, whereas Symfony had better performance at the intermediate range (highest MTF at ~2.00 D and ~2.50 D). All lenses showed comparable MTFs at ~1.50 D and ~3.00 D. Furthermore, the energy distribution was asymmetrical for both trifocal IOLs and more pronounced for FineVision than AT LISA; Symfony showed a symmetrical energy distribution.67

**CLINICAL OUTCOMES WITH PANOPTIX**

**Noncomparative Studies**

Kohnen et al (2017)27 reported good visual performance of PanOptix at a range of distances (4 m, 80 cm, 60 cm, and 40 cm), in particular at intermediate VA (logMAR >0.1), with the best VA at 60 cm, in a 3-month prospective study (n = 27). In total, 87% and 96% of eyes achieved a monocular uncorrected distant VA (UDVA) of ≤0.10 logMAR and ≤0.2 logMAR, respectively. Similarly, 85% and 91% of eyes achieved monocular uncorrected near VA (UNVA) of ≤0.10 logMAR and ≤0.2 logMAR, respectively; 50% achieved a UNVA of at least 0.0 logMAR. In all, 83% and 94% of eyes demonstrated an uncorrected intermediate VA (UIVA) of at least 0.2 logMAR at 80 cm and at 60 cm, respectively. The best VA was obtained at 0.00 D (4 m) and ~2.00 D (50 cm) in both monocular (~0.05 logMAR and 0.01 logMAR) and binocular (~0.07 logMAR and ~0.02 logMAR) defocus curves. The mean CS (measured using the Frankfurt-Freiburg Contrast and Acuity Test System) in photopic, mesopic, and mesopic-with-glare lighting conditions was 1.55 ± 0.35, 0.91 ± 0.26, and 0.86 ± 0.26 logCSW, respectively.10

This study used a short quality of vision (QoV) questionnaire (19 items) to assess patient-reported outcomes based on presence of visual disturbances and lifestyle activities, choice of IOL, and spectacle independence. Complete spectacle independence was achieved by 96% of patients with only 1 patient (1/27) reporting the use of spectacles for far distance. In all, 93% of patients reported experiencing an optical phenomena (89% halos, 11% glare, 7% double vision, 4% each ghosting and distorted vision).10 Although the reported incidence for far distance halos was high, patients reported that it was not bothersome. In all, 81% of patients responded that they would choose the same IOL again and would recommend it to others. For daily life activities, patients rated (score range: 1 = good to 6 = bad) a good mean score for the quality of uncorrected vision of 2.1 ± 0.54 for distance activities (car driving, TV, theatre, among others), and of 1.8 ± 0.10 for near and intermediate distance (cooking, computer, musical instrument, newspaper).10

Lawless et al (2017),17 in a retrospective case series study (n = 33), reported excellent unaided vision at all distances with PanOptix (Table 2). An uncorrected VA of 20/40 Snellen equivalent or better was achieved by all patients for distance and near positions and by 88.9% of patients for the intermediate position.17 In all, 78.8% of patients achieved UDVA of 0.01 ± 0.10 logMAR (~20/20 Snellen equivalent UDVA or better) and 85.2% achieved a mean UNVA of 0.11 ± 0.04 logMAR. Halos of moderate-severity were reported by 15% of patients in the early postoperative period but it did not impair their activities, and the complaints diminished by the subsequent postoperative visits (between 4 weeks and 3 months).17

Garcia-Perez et al (2017)19 reported excellent visual outcomes in patients (n = 58) implanted with PanOptix during the 1-month follow-up (Table 2). Monocular and binocular VA was measured at 33 cm (for near) and at 60 cm (for intermediate). No significant differences in distance, intermediate, or near VA and distance CS (P > 0.05 for all spatial frequencies measured using the functional acuity contrast test [Test SV-1000] of the CC-100 (HW 5.0 Series system) in mesopic and photopic conditions were noted, supporting the fact that the visual performance of PanOptix is consistent across different levels of illumination. All patients
### TABLE 3. A Summary of Uncorrected Visual Acuity Outcomes and Performance Reported for the FineVision Micro F Trifocal IOL, in Clinical Studies

| First Author | Study Design (Follow-Up Period) | Surgery | IOL | Patient (Eyes) | UDVA (logMAR) | IVUA (logMAR) | UNVA (logMAR) | Other Key Findings |
|--------------|--------------------------------|---------|-----|----------------|---------------|---------------|---------------|-------------------|
| Bilhão-Calabuig et al (2017) 2 | Retrospective, nonrandomized (3 mo) | Cataract | FineVision & AT LISA | 50 (100) | 0.01 ± 0.05 | -0.02 ± 0.05 | -0.05 ± 0.12 | Spectacle independence >98% in both groups for distance and intermediate vision; 92% in AT LISA and 95% in FineVision (P < 0.001) had Spectacle independence for near vision; 98% of patients were “satisfied” to “very satisfied” |
| Ferreira-Rios et al (2018) 5 | Prospective, case series (6 mo) | Cataract | FineVision | 15 (30) | A 6 m 0.06 ± 0.11 | At 70 cm 0.04 ± 0.08 | At 40 cm 0.05 ± 0.08 | Spectacle independence 86.6%, overall patient satisfaction was excellent |
| Muniz-de-la-Casa et al (2016) 3 | Case series (3 months) | Cataract | FineVision & AT LISA | 90 (00) | 0.05 ± 0.06 | -0.04 ± 0.11 | 0.25 ± 0.10 | No differences in CS between 2 IOL groups |
| Pinus-Puche et al (2016) 2 | Prospective, nonrandomized (3 mo) | Cataract | FineVision | 20 (40) | 0.02 ± 0.04 | 0.04 ± 0.05 | 0.11 ± 0.05 | No significant differences in CS function between trifocal and other multifocals |
| Coheefer (2016) 28 | Prospective, randomized (6 mo) | Cataract | FineVision & AT LISA | 27 (54) | A 64 cm 0.07 ± 0.05 | A 70 cm 0.01 ± 0.00 | A 33 cm 0.01 ± 0.00 | No significant differences in CS function between the trifocal and bifocal IOL; spectacle independence achieved by 100% (FineVision) and 92% (Tecnis) of patients; 58% (FineVision) and 75% (Tecnis) of patients reported discomfort in night vision; patient satisfaction was 92–93% in the 2 groups |
| Junier et al (2015) 29 | Prospective, randomized (6 mo) | Cataract | FineVision & AT LISA | 28 (56) | -0.01 ± 0.11 | 0.00 ± 0.09 | 0.25 ± 0.09 | 80% complete spectacle independence with FineVision vs 50% in the bifocal group. No significant differences in refractive outcomes, reading speed, or patient satisfaction were observed |
| Marques and Ferreira (2015) 30 | Prospective, comparative (3 mo) | Cataract | FineVision & AT LISA | 30 (60) | 0.02 ± 0.02 | 0.00 ± 0.01 | 0.10 ± 0.05 | At the spatial frequencies tested, the binocular CS was similar between the 2 IOLs. Complete spectacle independence achieved in both groups. No significant difference observed in dysphotopic scores of the 2 IOLs |
| Coheefer et al (2014) 31 | Prospective, randomized (12 mo) | Cataract | FineVision | 99 (198) | 0.01 ± 0.07 | 0.10 ± 0.03 | 0.15 ± 0.03 | Complete spectacle independence achieved in both groups. No significant difference observed in dysphotopic scores of the 2 IOLs |
| Alio et al (2013) 32 | Prospective, noncomparative (6 mo) | Cataract | FineVision | 20 (40) | 0.18 ± 0.13 | A 80 cm 0.06 ± 0.01 | A 30 cm 0.20 ± 0.01 | No intraoperative complications or PCO cases were reported; only 1 patient reported halos |
| Veyhmann and Heineham (2013) 33 | Prospective, consecutive (6 mo) | Cataract or RLE | FineVision | 25 (50) | -0.04 ± 0.09 | A 70 cm 0.10 ± 0.05 | A 35 cm 0.02 ± 0.06 | CS did not decrease upon dim conditions; 68% of patients did not complain of halos, 100% (distance) and 80% (near) spectacle independence |
| Sheppard et al (2013) 34 | Prospective, nonrandomized (2 mo) | Cataract | FineVision | 15 (30) | 0.19 ± 0.09 | — | — | Binocular CS was better than monocular values. No patient reported adverse photic phenomena. NAVQ scores for subjective satisfaction with near vision were high |
| Coheefer et al (2012) 35 | Prospective (6 mo) | Cataract | FineVision | 47 (94) | 0.02 ± 0.09 | 0.05 ± 0.08 | 0.10 ± 0.04 | No patient reported seeing ghost images |

Search term in Medline/Pubmed: (trifocal) AND FineVision Micro F; [(trifocal) AND FineVision]. In total, 43 articles were obtained and a manual search was also performed. After screening (non-English, optical bench/in vitro studies; studies not reporting VA outcomes and FineVision toric IOL articles were excluded) and removing duplicates, 14 studies were included. VA is reported in mean ± SD. Unless specified the reported measurements are of binocular uncorrected intermediate (80 cm), and uncorrected near (at 40 cm) visual acuity. CS indicates contrast sensitivity; IOL, intraocular lens; logMAR, logarithm of the minimal angle of resolution; NAVQ, near activity visual questionnaire; PCO, posterior capsular opacification; RLE, refractive lens exchange; SD, standard deviation; UDVA, uncorrected distance visual acuity; IVUA, uncorrected intermediate visual acuity; UNVA, uncorrected near visual acuity; VA, visual acuity. *P < 0.05 vs comparator. | Monocular VA reported. | Distance corrected VA reported. | This study included 6 IOLs |
achieved a binocular uncorrected VA better than 0.3 logMAR (20/40 Snellen equivalent) for distance and near vision, and 94.8% of patients did so for intermediate vision. The monocular defocus curves showed that VA better than 0.2 logMAR was maintained between −2.50 and +0.50 D. Overall, 94.8% of patients in this study achieved complete spectacle independence; 3 (5.1%) patients reported using spectacles for some activities.19

The study used the Catquest 9-SF questionnaire to evaluate patient satisfaction. A high level of satisfaction was observed: 84.5% patients reported no difficulties and 15.5% reported some difficulties related to vision in their daily lives; >79% of patients reported having no difficulties in performing all tasks. Driving at night was the most challenging activity with 25.9% of patients citing difficulty as occasional or often; 32.8% reported seeing halos often or always with low illumination and 10.3% reported glare. One case of posterior capsule opacification (PCO) was reported and was scheduled for neodymium-doped yttrium aluminum garnet (Nd:YAG) capsulotomy.19

Alo et al (2018),26 in a 6-month prospective case series (n = 26, 52 eyes), reported significant improvement in uncorrected and corrected VA outcomes at 1 month after PanOptix implantation, and the VA remained stable through the 6-month follow-up. The monocular defocus curves showed that a VA better than 0.3 logMAR was maintained between +0.50 D and −3.00 D. The CS (assessed by Pelli-Robson) at 3 months after surgery was 1.58 ± 0.18 (monocular) and 1.86 ± 0.15 (binocular) Log Units. CS values obtained in this study were similar to normal visual quality (average 0.9 logMAR). Consistent with their optical design and properties, the defocus curves of PanOptix and Symfony showed a distinctly different pattern of vergence. Overall, PanOptix demonstrated significantly better near (at 40 cm) vision than Symfony. de Medeiros et al (2017)18 compared the visual outcomes and CS between 0.3 and 0.4 logMAR. In this study, some patients (n = 11/30) in the FineVision group had bilateral implantation with the toric IOL and 2 other patients received the toric version in one eye.16

On all parameters for visual disturbances, frequency, severity, and degree of bothersomeness, the QoV questionnaire mean Rasch scores were lower (ie, better performance) for PanOptix than for FineVision, even though there was no statistically significant difference between the 2 groups. Halos (mild to moderate) were the most frequently reported phenomenon with an incidence of 60% in each group. However, only 3 patients with FineVision and 1 with PanOptix reported the halos to be a little bothersome, whereas others did not find it to have any impact on QoL.16

**PanOptix Versus AT LISA IOL**

One randomized, double-masked, prospective and multicenter study compared the performance of PanOptix (n = 93) with the AT LISA IOL (n = 89).27 The PanOptix group achieved significantly better binocular UIVA at 60 cm (P < 0.002) and binocular UNVA at 40 cm (P < 0.003) versus AT LISA. On the defocus curve, the PanOptix group achieved a mean VA of 20/25 or better from +0.50 D to −2.50 D and higher (ie, better) mean VA between −1.50 D and −2.50 D versus AT LISA. Both IOL groups demonstrated similar CS in photopic or mesopic conditions with and without glare. Patient satisfaction was >95% in both groups at the 6 months’ visit. Mild halos and glare were reported by a few patients in both groups within 1 to 2 weeks of implantation; these resolved without intervention.27

**PanOptix Versus Symfony IOL**

Six studies have compared the optical performance of PanOptix with Symfony; 4 studies had an additional comparator IOL group (Table 2).18,21–25,64 Consistent with their optical design and properties, the defocus curves of PanOptix and Symfony showed a distinctly different pattern of vergence. Overall, PanOptix demonstrated significantly better near (at 40 cm) vision than Symfony.

Comparative Studies

**PanOptix Versus FineVision IOL**

One study compared the refractive outcomes with PanOptix versus the FineVision IOL.16 Two additional studies compared PanOptix, FineVision, and the Symfony IOLs, and the outcomes in these studies are discussed under Symfony IOL.24,25

Gundersen and Potvin (2017)16 compared the VA, low contrast VA and QoV of PanOptix (n = 30) with FineVision (n = 30) in a 6-month follow-up study. The study reported significantly better intermediate VA at 60 cm with PanOptix (P = 0.01); no significant differences were observed at other distances.16 The binocular defocus curves of the 2 trifocals showed a significant difference at 3 defocus levels: the FineVision IOL demonstrated a better performance at −1.0 D (P = 0.02), a defocus corresponding to viewing at 80 cm; PanOptix demonstrated better performance at −1.5 D and −2.00 D (P < 0.01 for both), which is at a viewing distance of ~60 to 45 cm. For both IOLs, the preferred reading distance between 42 and 43 cm and PanOptix demonstrated a better VA at the preferred reading distance (P = 0.04). Both groups had a mean low contrast VA between 0.3 and 0.4 logMAR. In this study, some patients (n = 11/30) in the FineVision group had bilateral implantation with the toric IOL and 2 other patients received the toric version in one eye.16

On all parameters for visual disturbances, frequency, severity, and degree of bothersomeness, the QoV questionnaire mean Rasch scores were lower (ie, better performance) for PanOptix than for FineVision, even though there was no statistically significant difference between the 2 groups. Halos (mild to moderate) were the most frequently reported phenomenon with an incidence of 60% in each group. However, only 3 patients with FineVision and 1 with PanOptix reported the halos to be a little bothersome, whereas others did not find it to have any impact on QoL.16

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| Author | Study Design (Follow-Up Period) | Surgery | IOL | Patient (Eyes) | UDVA (logMAR) | UNVA (logMAR) | UNVA (logMAR) | Other Key Findings |
|--------|--------------------------------|---------|-----|---------------|---------------|---------------|---------------|-------------------|
| Yang et al (2018)<sup>66</sup> | Prospective, (3 mo) | Cataract | AT LISA | 26 (30) | 0.05 ± 0.10 | 0.23 ± 0.12 | 0.21 ± 0.15 | High levels of patient satisfaction and 100% spectacle independence; none of the patients reported glare or halos |
| Steinwender et al (2018)<sup>55</sup> | Retrospective, case series (3 mo) | Cataract | AT LISA (myopic) AT LISA (control) | 19 (36) | 0.06 ± 0.06 | 0.08 ± 0.10 | 0.01 ± 0.10 | Satisfactory VA outcomes at various distances achieved in highly myopic eyes with low IOL power; excellent VA achieved in eyes with higher refractive power |
| Liu et al (2018) | Prospective, nonrandomized (3 mo) | Cataract | AT LISA | 55 (110) | 0.02 ± 0.04 | 0.10 ± 0.26 | 0.15 ± 0.07 | Halos reported in 84% and 86.7%, and glare by 40% and 33.3% in the trifocal and bifocal group respectively. Complete spectacle independence: 88% in trifocal vs 80% in bifocal. High patient satisfaction 90%–92% was reported in both IOL groups |
| Kim et al (2018) | Retrospective, (1 mo) | Cataract or RLE | AT LISA | 23 (46) | 0.06 ± 0.06 | 0.22 ± 0.10 | 0.05 ± 0.09 | No significant differences were found in reading speed between the 2 IOLs at any letter sizes |
| Mencucci et al (2017)<sup>60</sup> | Prospective, (3 mo) | Cataract | AT LISA | 21 (42) | 0.00 ± 0.05 | 0.11 ± 0.07 | 0.18 ± 0.05 | Patient satisfaction was very high, spectacle independence was 100% for far and intermediate distances; ~71.4% of patients required glasses “sometimes” for near vision |
| Kaynak et al (2017)<sup>48</sup> | Prospective, comparative (12 mo) | Cataract | AT LISA AT LISA 801M | 52 (104) | −0.02 ± 0.01 | 0.11 ± 0.06 | 0.13 ± 0.12 | Reading acuity at preferred distance was comparable between the trifocal and bifocal IOLs |
| Alio et al (2018)<sup>48</sup> | Prospective, randomized (6 mo) | Cataract | AT LISA AT LISA 809M | 52 (104) | −0.03 ± 0.07 | 0.24 ± 0.21 | 0.11 ± 0.15 | Patient satisfaction and CS outcomes were higher with the trifocal IOL than with bifocal IOLs |
| Kretz et al (2016)<sup>47</sup> | Prospective (3 mo) | Cataract | AT LISA | 50 (100) | 0.04 | 0.04 | 0.04 | Patient satisfaction was 80%; low mean spectacle dependence scores; low occurrence of visual disturbances |
| Author                          | Study Design (Follow-Up Period) | Surgery   | IOL                  | Patient (Eyes) | UDVA (logMAR) | UIVA (logMAR) | UNVA (logMAR) | Other Key Findings                                                                 |
|--------------------------------|--------------------------------|-----------|----------------------|----------------|---------------|---------------|---------------|-----------------------------------------------------------------------------------|
| Mendicute et al (2016)³³       | Prospective, noncomparative (3 mo) | Cataract  | AT LISA              | 104 (208)      | 0.03 ± 0.09   | 0.10 ± 0.15   | 0.15 ± 0.14   | High patient satisfaction and >90% complete spectacle independence; ~80.0% of patients perceived some level of halos though it was not bothersome in 75% of patients. |
| Alfonsi et al (2016)³²         | Prospective (6 mo)              | RLE       | AT LISA              | 102 (204)      | 0.11 ± 0.16²  |                | At 40 cm      | 0.07 ± 0.11                                         | A reduction of the mesopic CS values both with and without glare vs photopic conditions was observed. |
| Postolache and Postolache³⁶   | Prospective, (6 mo)             | Cataract  | AT LISA 809M         | 18 (36)        | 0.84          | 0.88          | At 70 cm      | 0.76 ± 0.26                            | Patient satisfaction was very good for both implants and most patients did not request any additional correction. |
| Mojzis et al (2015)³⁵         | Prospective, consecutive (12 mo) | Cataract  | AT LISA              | 60 (120)       | 0.03 ± 0.13   |                | At 80 cm      | 0.11 ± 0.13                                         | Significant PCO was found in 19 eyes; (15.8%); Nd:YAG capsulotomy was required in 4 eyes (3.3%). |
| Kohnen et al (2016)³⁶³         | Prospective (6 mo)              | Cataract  | AT LISA              | 27 (54)        | −0.06 ± 0.10  | 0.00 ± 0.12   | 0.04 ± 0.10   | High patient satisfaction and spectacle independence; the most common optical phenomena were halos (60%) and glare (28%). |
| Mojzis et al (2014)³³³         | Prospective, comparative (3 mo)  | Cataract  | AT LISA 801          | 30 (60)        | −0.05 ± 0.08  | 0.00 ± 0.13   | At 80 cm      | 0.03 ± 0.08                                         | CS was similar with both IOL types. |
| Law et al (2014)³³           | Prospective (6 mo)              | Cataract  | AT LISA              | 30 (60)        | 0.05 ± 0.07³  | 0.16 ± 0.17³  | 0.16 ± 0.07   | One patient required bilateral Nd:YAG capsulotomy due to clinically significant PCO; overall, there was a high patient satisfaction; 13%–16% reported difficulty in performing intermediate/near tasks; halos and glare were reported in 40% and 13% of patients, respectively. |
| Mojzis et al (2014)³³³         | Prospective (6 mo)              | RLE       | AT LISA              | 30 (60)        | −0.03 ± 0.09  | At 66 cm      | 0.08 ± 0.10 | At 33 cm      | 0.20 ± 0.12                                             | Total internal aberrations decreased significantly. No serious complications, such as posterior capsule rupture, endophthalmitis, or corneal decompensation occurred during the follow-up. |

Search term in Medline/PubMed: At LISA (All Fields) AND [trifocal (All Fields) AND IOL (All Fields)]. In total, 49 articles were obtained and a manual search was also performed. Following screening (non-English, optical bench in vitro studies; studies not reporting mean VA, meta-analysis and AT LISA toric IOL articles were excluded) and removing duplicates, 16 studies were included. CS, contrast sensitivity; IOL, intraocular lens; logMAR, logarithm of the Minimal Angle of Resolution; Nd:YAG, neodymium-doped yttrium aluminum garnet; PCO, posterior capsular opacification; RLE, refractive lens exchange; SD, standard deviation; UDVA, uncorrected distance visual acuity; UIVA, uncorrected intermediate visual acuity; UNVA, uncorrected near visual acuity; VA, visual acuity. VA is reported in mean ± SD. Unless specified the reported measurements are of binocular uncorrected intermediate (80 cm), and uncorrected near (at 40 cm) VA. *P < 0.05 vs comparator. §Monocular VA reported. ¶Decimal value reported. © Distance corrected VA reported.
A Summary of Uncorrected Visual Acuity Outcomes and Performance Reported for the Symfony EDOF IOL in Clinical Studies

| First Author | Study Design (Follow-Up Period) | Surgery | IOL | Patient (Eyes) | UDVA (LogMAR) | UIVA (LogMAR) | UNVA (LogMAR) | Other Key Findings |
|--------------|--------------------------------|---------|-----|----------------|---------------|---------------|---------------|-------------------|
| Hogarty et al (2018) | Retrospective, EDOF targeted for monovision (5 mo) | Cataract | Symfony | 88 (76) | At 1 m: 0.04 ± 0.11, 0.02 ± 0.11 | 0.12 ± 0.12 | 0.18 ± 0.08 | Spectacle independence was achieved by 69% distances and 67% (near) of patients with EDOF IOL |
| Gunes et al (2018) | Prospective, EDOF targeted for monovision (6 mo) | Cataract | Symfony | 25 (30) | At 60 cm: 0.09 ± 0.10, 0.24 ± 0.13 | 0.15 ± 0.11 | Excellent outcomes for far and intermediate vision, satisfactory outcomes for near vision; spectacle independence was achieved by 96% (far and intermediate) and 86% (near); dysphotopsia was reported by 64% (severe in 12%) of patients |
| Pilar et al (2018) | Prospective, nonrandomized (4 mo) | Cataract | Symfony | 185 (30) | At 60 cm: 0.02 ± 0.08, 0.06 ± 0.06 | 0.11 ± 0.07 | 0.26 ± 0.1 | Binocular CS with glare similar to monofocal IOL; spectacle use reported by 40% and 20% for near vision and intermediate vision respectively, in the EDOF group |
| Pedrotti et al (2018) | Prospective, nonrandomized (6 mo) | Cataract or RLE | Symfony | 28 (40) | At 6 m: 0.09 ± 0.05, 0.11 ± 0.08 | 0.17 ± 0.06 | Similar CS, low perception of halos and high patient satisfaction with both IOLs; 5% of patients in FineVision and 10% in Symfony needed occasional spectacles for near vision; 5% of patients in FineVision group had grade 1 PCO |
| Pedrotti et al (2016) | Prospective, comparative (1 y) | Cataract | Symfony | 40 (60) | At 6 m: 0.99 ± 0.19 | 0.99 ± 0.13 | Excellent VA achieved with high levels of spectacle independence; Overall, high patient satisfaction scores and minimal photic phenomena |
| Cochenier (2017) | Prospective case series (4–6 mo) | Cataract or RLE | Symfony | 41 (62) | At 6 m: 0.03 ± 0.09 | 0.12 ± 0.10 | 0.37 ± 0.11 | EDOF IOL provided better distance vision (vs all test IOLs) and better intermediate VA than monofocal and Restore multifocal +3.0 D. Spectacle independence was significantly lower with EDOF than with Restore multifocal +3.0 D |
| Sachdev et al (2017) | Prospective, randomized, comparative (4–6 mo) | Cataract or RLE | Symfony | 50 (100) | At 70 cm: 0.99 ± 0.13 | 0.99 ± 0.16 | CS significantly better with Symfony vs both trifocals. Halo (2%, 13%, and 5%) and glare (20%, 13%, and 6%) were reduced using Symfony. With AT LISA, 6.7% of patients used glasses as an aid; spectacle independence: 100% for both trifocals, 94% with Symfony. High patient satisfaction with Symfony and AT LISA while there was 20% patient dissatisfaction with FineVision |

Search term in Medline/PubMed: [extended depth focus] OR extended vision] AND Symfony; [extended depth of focus] AND Symfony; [extended range of vision] AND Symfony. Following screening (non-English, optical bench/in vitro studies, studies not reporting mean VA, meta-analysis and toric IOL articles were excluded) and removing duplicates articles, 9 studies were included. Unless specified the reported measurements are of binocular uncorrected intermediate (60 cm) and uncorrected near (at 40 cm) VA. CS indicates contrast sensitivity; EDOF, extended depth of focus; IOL, intraocular lens; logMAR, logarithm of the Minimal Angle of Resolution; Nd:YAG, neodymium-doped yttrium aluminum garnet; PCO, posterior capsular opacification; RLE, refractive lens exchange; UDVA, uncorrected distance visual acuity; UIVA, uncorrected intermediate visual acuity; UNVA, uncorrected near visual acuity; VA, visual acuity.

*P < 0.05 vs comparator group.

†P < 0.05 vs Symfony.

†Decimal VA value reported.
the 2 IOL groups at higher frequencies (12 and 18 cpd). Under mesopic conditions without glare, the mixed EDOF IOL group showed better CS at 1.5, 6 and 12 cpd ($P < 0.05$).^{18}

Monaco et al (2017)^22 in a randomized clinical trial compared the visual outcomes of PanOptix (n = 20) and Symfony (n = 20) with the monofocal AcrySof IOL (n = 20). Overall, both the multifocal and EDOF IOLs performed significantly better for intermediate and near vision than the monofocal IOL. PanOptix demonstrated significantly better UIVA, UNVA, and corrected near VA than Symfony (Table 2). PanOptix showed a statistically significantly better VA, ~1 line better VA, at defocus level −1.5 D, and from −2.5 D to −4.0 D than the Symfony IOL. Spherical aberration values at 5.0 mm pupil diameter were significantly lower with PanOptix than Symfony. Both the PanOptix and Symfony IOLs had the same level of retinal stray light as the monofocal IOL in the study.^22

The mean dysphotopsia score in the QoV questionnaire did not show a difference between the PanOptix and Symfony IOLs but their scores were significantly higher in comparison with monofocal SN60WF IOL score. The most frequently reported visual side effect was halo; 15% (n = 3) of patients in the PanOptix group and 25% (n = 5) in the Symfony group rated it as occurring “quite often.”^22 Halo was also the most severe and bothersome visual symptom in both the PanOptix and Symfony IOL groups that was rated “moderate” and “quite often” by 15% (n = 3) and 20% (n = 4) of patients with PanOptix and Symfony, respectively. Overall, 85% and 70% of patients with PanOptix and Symfony achieved complete spectacle independence, respectively. In all, 15% (n = 3) of patients in the PanOptix group and 25% (n = 5) in the Symfony group reported spectacle use “sometimes.”^22

Ruiz-Mesa et al (2017)^23 compared VA and optical performance of PanOptix (n = 20) with Symfony (n = 14). In this study, the distance corrected intermediate vision between PanOptix and Symfony was similar, both at 80 cm and 60 cm (Table 2). The preferred reading distance for the 2 IOLs was in the range of 37 to 39 cm. However, a significantly better VA for near and preferred reading distance was achieved with PanOptix than Symfony ($P < 0.001$). The defocus curves showed a comparable pattern for distance and intermediate vision between the 2 IOLs but significantly better near outcomes with PanOptix, from −2.00 D to −4.00 D, than Symfony ($P < 0.001$). PanOptix showed a continuous range vision (VA >0.1 logMAR) from 0.00 to −3.00 D; Symfony had a continuous range vision (VA >0.1 logMAR) from 0.00 to −1.5 D. The CS under photopic and mesopic conditions (evaluated using the Functional Acuity Contrast Test) were similar between the IOL groups at all spatial frequencies and illumination settings. The high order aberrations did not differ significantly between the 2 IOLs. Halometry data showed similar dysphotopic phenomena/perception of halos for both IOLs.^{21}

Mencucci et al (2018)^23 compared the 3-month postoperative VA outcomes in patients implanted with PanOptix (n = 20), AT LISA (n = 20), and Symfony (n = 20). The 3 IOLs showed significant differences in intermediate vision (Table 2). PanOptix provided better VA at 60 cm than the other 2 IOLs; similarly, at 80 cm, Symfony was significantly better than the other 2 IOLs. The near vision was relatively better with PanOptix than AT LISA; both IOLs showed significantly better near vision than Symfony (Table 2). The distance CS results were significantly better with Symfony than AT LISA (0.24 logCS, $P < 0.001$) and PanOptix (0.20 logCS, $P < 0.001$) IOLs, under both photopic and mesopic conditions (obtained by adjusting the potentiometer of a halogen lamp according to the room illumination measurements provided by a light meter ST-1300). The 3 IOLs showed similar near reading performance in all parameters (maximum reading speed, critical print size, and reading acuity).^23

Halos and glare were the most frequently reported visual disturbances by 70% and 50% of patients, respectively, in each group, although the symptoms were rated mostly as mild or, at least, as not disturbing by the patients. In the satisfaction questionnaire, all patients reported complete satisfaction with the choice of IOL. Complete spectacle independence was achieved for distance and intermediate tasks. More patients in the Symfony group (87%) than the AT LISA (33%) and PanOptix (17%) groups reported “often use” of spectacles for near vision.^23

Escandon-Garcia et al (2018)^24 compared PanOptix (n = 7), FineVision (n = 15), and Symfony (n = 23) and observed no significant difference among the IOLs for distance vision (Table 2). The defocus pattern of the 3 IOLs was different for intermediate vision; Symfony showed a better performance at −1.00 D/1 m ($P = 0.030$), whereas both PanOptix and FineVision provided significantly better near vision at −2.5 D (40 cm; $P = 0.007$) and −3.0 D (33 cm; $P = 0.014$), respectively. PanOptix also showed an improved VA at −2.00 D (50 cm) defocus compared with FineVision and Symfony. There was no significant difference between the IOLs for distance VA (Table 2). The CS performance (evaluated using the Functional Visual Analyzer) was similar among the IOLs under photopic and scotopic condition; however, the CS of PanOptix was lower at a spatial frequency of 1.5 ($P = 0.049$) in photopic conditions.^{24}

Light distortion analysis was measured for size, shape, and regularity of the halo surrounding a source of glare. Light distortion values (ie, light disturbances) were lower with PanOptix than the other 2 IOLs; Symfony showed the highest average values for the distortion index, although the difference was not statistically significant. The QoV questionnaire scores were worst for the Symfony IOL in all categories (frequency, severity, and bothersome scale) than for the other 2 IOLs and the difference was statistically significant for the bothersome subscale.^{24}

Cochener et al (2018)^25 did not observe any significant difference in the VA for distance vision (both monocular and binocular) and intermediate VA (monocular) for the PanOptix (n = 20), FineVision (n = 20), and Symfony (n = 20) IOLs (Table 2). Both PanOptix and FineVision IOLs reported significantly better near vision compared with Symfony ($P = 0.002$). The distance CS (evaluated using MTF) was comparable for all 3 IOLs, and CS decreased under mesopic conditions. High-order aberrations were more common in the Symfony group. In the QoV questionnaire, night time visual disturbances, dry eye, halos, and glare were reported by <1% of patients in each IOL group. The proportion of patients with spectacle independence was comparable across all 3 IOLs (89%, 90%, and 86% in the PanOptix, FineVision, and Symfony groups, respectively).^{25}

**PHOTIC PHENOMENA AND QoL OUTCOMES WITH PANOPTIX**

The functional and safety results have been described in the previous section for each study. In all, 8 studies used questionnaires to assess patient satisfaction and visual symptoms.
Perception of halos and difficulty in night driving were the most common visual disturbances reported by patients. The reported incidence of halos showed a wide variation among the studies (<1% to 89%). However, the majority of patients reported that the visual side effects had no impact on their QoL. High patient satisfaction and spectacle independence were reported with PanOptix, and there were no reports of patients opting for lens exchange due to photic phenomena in any of the studies.

Incidence of PCO and Nd:YAG capsulotomy was very low with PanOptix; only 1 case was reported across the published studies. Consistent with this finding, Kacerovsky (2018), in a 6-month comparative study (n = 100/per group) observed the PCO rate to be only 0.5% with PanOptix (n = 1) versus 6% (n = 12) with AT LISA (P = 0.021).

**SUMMARY**

Trifocal IOLs have been developed to address the limitations of bifocal IOLs, namely impaired intermediate vision, to improve patient experience after cataract surgery. To create an intermediate vision, the trifocal IOLs split light energy at a third focal point in addition to the far and near zones. Trifocal IOLs achieve a wide range of vision by using different optical designs and technologies, such as diffractive, refractive, and hybrid refractive-diffractive patterns. FineVision Micro F and AT LISA trifocal IOLs were the first trifocal IOLs introduced and have an intermediate focus at 80 cm. Studies have shown that, in general, these trifocal IOLs provide good VA across all distances, high patient satisfaction, and spectacle independence. Overall, high patient satisfaction along with complete spectacle independence for all distances (>85% across studies) has been observed with MIOLs. Overall, high patient satisfaction along with complete spectacle independence for all distances (>85% across studies) has been observed with MIOLs. The EDOF IOLs also show good outcomes for far and intermediate vision and limited outcomes for near vision. An overview of performance of FineVision, AT LISA, and Symfony IOLs in clinical studies is also provided so that the readers can gain an overall perspective on the performance of these MIOLs as well.

AcrySof IQ PanOptix is one of the latest presbyopia-correcting MIOLs based on an optical technology which is unlike that of traditional trifocal IOLs, and is designed to help patients accomplish near and intermediate tasks with greater ease. PanOptix has 3 differentiating features over the trifocals, AT LISA, Fine Vision, and the EDOF IOL Symfony. PanOptix has an intermediate focal point at 60 cm (relaxed arms’ length) which is a more natural and comfortable distance to perform routine daily activities versus 80 cm for the trifocals and Symfony [a distance far away for most patients to comfortably reach, 80 cm is the arm’s length of a person ~205 cm (ie, 6 ft 8 inches) tall]. Human factor surveys and the Occupational Safety and Health Administration recommend a viewing distance of 20 to 25 inches (~50–63 cm) while performing tasks using digital screens. PanOptix also has a higher energy utilization (up to 88%) than both the trifocals (85%–86%), and a smaller diffractive zone (4.5 mm) than trifocals and Symfony (6.0 mm), a feature that makes functional vision to be less dependent on pupil size or lighting conditions and provides better CS.

The defocus curves for PanOptix, the trifocal (FineVision, and AT LISA), and Symfony IOLs show a distinct pattern that is consistent with their respective optical designs. For PanOptix, studies consistently showed a good VA over a wide range of defocus levels (+0.50 D and −3.0 D). There was no significant difference among PanOptix, the trifocal IOLs, and Symfony IOL for distance vision. With reference to UIVA (at 60 cm), PanOptix had a better VA performance than Symfony and the trifocals. PanOptix performed significantly better for near vision compared with Symfony, FineVision, and AT LISA. Symfony demonstrated a better intermediate performance than trifocals, and AT LISA and Fine Vision showed better performance at distance and near vision than the EDOF IOL.

Overall, the CS under both photopic and mesopic conditions was similar among the PanOptix, AT LISA, FineVision, and the EDOF IOL, and was found to be within the normal range expected for the age group of patients. The lack of agreement between the CS tests used makes it difficult to directly compare outcomes of different studies.

Halos, glare, and difficulty in night time driving are the most frequently reported visual side effects with PanOptix, and with the trifocals and Symfony IOLs. A relatively higher frequency or a greater degree of bother is reported with Symfony than with PanOptix and trifocal IOLs for photic phenomena. In majority of PanOptix patients photic disturbances had no impact on their daily life and these were reported to decrease with time. This phenomenon has been termed as neuroadaptation, wherein patients require a certain postoperative period to adjust to the retinal images, and this is frequently observed with MIOLs. Overall, high patient satisfaction along with complete spectacle independence for all distances (>85% across studies) has been observed with PanOptix. A relatively higher frequency or a greater degree of bother is reported with Symfony than with PanOptix and trifocal IOLs for photic phenomena. In majority of PanOptix patients photic disturbances had no impact on their daily life and these were reported to decrease with time. This phenomenon has been termed as neuroadaptation, wherein patients require a certain postoperative period to adjust to the retinal images, and this is frequently observed with MIOLs. Overall, high patient satisfaction along with complete spectacle independence for all distances (>85% across studies) has been observed with PanOptix. A relatively higher frequency or a greater degree of bother is reported with Symfony than with PanOptix and trifocal IOLs for photic phenomena. In majority of PanOptix patients photic disturbances had no impact on their daily life and these were reported to decrease with time. This phenomenon has been termed as neuroadaptation, wherein patients require a certain postoperative period to adjust to the retinal images, and this is frequently observed with MIOLs. Overall, high patient satisfaction along with complete spectacle independence for all distances (>85% across studies) has been observed with PanOptix. A relatively higher frequency or a greater degree of bother is reported with Symfony than with PanOptix and trifocal IOLs for photic phenomena. In majority of PanOptix patients photic disturbances had no impact on their daily life and these were reported to decrease with time. This phenomenon has been termed as neuroadaptation, wherein patients require a certain postoperative period to adjust to the retinal images, and this is frequently observed with MIOLs. Overall, high patient satisfaction along with complete spectacle independence for all distances (>85% across studies) has been observed with PanOptix.
clinical performance of the presbyopia-correcting IOL PanOptix, as reported in the literature.

Multifocality to some extent compromises the image quality and also reduces CS, and this is often a cause of patient dissatisfaction after MIOL implantation. The dysphotopsia associated with MIOLS usually tends to decrease with neuroadaptation. But adaptation is a variable process that depends both on the individual and IOL design, and some patients can find it challenging to wait for vision improvement. Thus, patient selection based on their visual needs and educating them of the potential optical side-effects that they may experience after an MIOL implantation, some of which may never resolve, is essential in setting realistic expectations. Patient personality traits have been shown to influence success with MIOLS.

In conclusion, MIOLs have today become very popular in the management of cataract and refractive error. With advances in technology, a range of MIOLs are available that can cater to a wide range of patients’ needs. The key is to identify the most suitable MIOL according to an individual’s personality, expectations, and preoperative condition, so as to yield best possible visual outcomes with maximum patient satisfaction and an enhanced QoL.

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REFERENCES
1. de Vries NE, Nuijts RM. Multifocal intraocular lenses in cataract surgery: literature review of benefits and side effects. J Cataract Refract Surg. 2013;39:268–278.
2. Leyland M, Zimicla E. Multifocal versus monofocal intraocular lenses in cataract surgery: a systematic review. Ophthalmol. 2003;110:1789–1798.
3. Cochrane B, Lafama A, Khoshnood B, et al. Comparison of outcomes with multifocal intraocular lenses: a meta-analysis. Clin Ophthalmol. 2011;5:45–56.
4. Salerno LC, Tiveron Jr , Allo JL. Multifocal intraocular lenses: types, outcomes, complications and how to solve them. Taiwan J Ophthalmol. 2017;7:179–184.
5. Breyer DRH, Kaymak H, Ax T, et al. Multifocal intraocular lenses and extended depth of focus intraocular lenses. Asia Pac J Ophthalmol (Phila). 2017;6:339–349.
6. Rosen E, Allo JL, Dick BH, et al. Efficacy and safety of multifocal intraocular lenses following cataract and refractive lens exchange: Metaanalysis of peer-reviewed publications. J Cataract Refract Surg. 2016;42:310–328.
7. Brito P, Salgado-Borges J, Neves H, et al. Light-distortion analysis as a possible indicator of visual quality after refractive lens exchange with diffractive multifocal intraocular lenses. J Cataract Refract Surg. 2015;41:613–622.
8. Intraocular Lens Market by Type (Traditional/Monofocal (Spheric, Aspheric), Premium (Multifocal, Accommodating, and Extended Depth of Focus), and Phakic), Material (PMMA, Foldable), End User (Hospital, Clinic), and Region - Global Forecast to 2022. Available at: https://www.marketsandmarkets.com/Market-Reports/intraocular-lens-market-263730551html.
9. Kohnen T. First implantation of a diffractive quadrafoil (trifocal) intraocular lens. J Cataract Refract Surg. 2015;41:2330–2332.
10. Kohnen T, Herzog M, Heimkepler E, et al. Visual performance of a quadrifoil (trifocal) intraocular lens following removal of the crystalline lens. Am J Ophthalmol. 2017;184:52–62.
11. FineVision Micro F Trifocal IOL. Available at: https://www.physiol.eu/en-US/Documents/brochure_finevision.pdf.
12. Gatinel D, Pagnoule C, Houbrechts Y, et al. Design and qualification of a diffractive trifocal optical profile for intraocular lenses. J Cataract Refract Surg. 2011;37:2060–2067.
13. FineVision trifocal hydrophobic IOL. Available at: https://www.physiol.eu/getattachment/291df20-8cece-424b-a8ad-b3b4f1760eb7/brochure_finevisionhp.
14. AT LISA Tri 839MP IOL. Available at: https://www.zeiss.com/meditec/int/products/ophthalmology-optometry/cataract/ol-implantation/mics-platform/mics-preloaded-trifocal-sol/at-lisa-tri-family/at-lisa-tri-family-product-details.html#technical-data.
15. Mojzis P, Pena-Garcia P, Liehneova I, et al. Outcomes of a new diffractive trifocal intraocular lens. J Cataract Refract Surg. 2014;40:60–69.
16. Gundersen KG, Potvin R. Trifocal intraocular lenses: a comparison of the visual performance and quality of vision provided by two different lens designs. Clin Ophthalmol. 2017;11:1081–1087.
17. Lawless M, Hodge C, Reich J, et al. Visual and refractive outcomes following implantation of a new trifocal intraocular lens. Eye Vis (Lond). 2017;4:10.
18. de Medeiros AL, de Araujo Rolim AG, Motta AFP, et al. Comparison of visual outcomes after bilateral implantation of a diffractive trifocal intraocular lens and blended implantation of an extended depth of focus intraocular lens with a diffractive bifocal intraocular lens. Clin Ophthalmol. 2017;11:1911–1916.
19. Garcia-Perez JL, Gross-Otero J, Sanchez-Ramos C, et al. Short term visual outcomes of a new trifocal intraocular lens. J Cataract Refract Surg. 2017;43:737–747.
20. Vilar C, Hida WT, de Medeiros AL, et al. Comparison between bilateral implantation of a trifocal intraocular lens and blended implantation of two bifocal intraocular lenses. Clin Ophthalmol. 2017;11:1393–1397.
21. Ruiz-Mesa R, Abengozar-Vela A, Ruiz-Santos M. A comparative study of the visual outcomes between a new trifocal and an extended depth of focus intraocular lens. Eur J Ophthalmol. 2018;28:182–187.
22. Monaco G, Gari M, Di Censo F, et al. Visual performance after bilateral implantation of 2 new presbyopia-correcting intraocular lenses: Trifocal versus extended range of vision. J Cataract Refract Surg. 2017;43:737–747.
23. Mencucci R, Favuzza E, Cuporossi O, et al. Comparative analysis of visual outcomes, reading skills, contrast sensitivity, and patient satisfaction with two models of trifocal diffractive intraocular lenses and an extended range of vision intraocular lens. Graefes Arch Clin Exp Ophthalmol. 2018;256:1913–1922.
24. Escandón-García S, Ribeiro FJ, McAlinden C, et al. Through-focus vision performance and light disturbances of 3 new intraocular lenses. J Refract Surg. 2018;34:511–514.
25. Cochrane B, Bontillier G, Lamard M, et al. A comparative evaluation of a new generation of diffractive trifocal and extended depth of focus intraocular lenses. Eur J Ophthalmol. 2018;28:419–424.
27. Lapid-Gortzaak L, Martinez A. Multicenter visual outcomes comparison of two trifocal presbyopia correcting intraocular lenses: 6-month postoperative results. Oral presentation at: XXXVI European Society of Cataract and Refractive Surgeons Meeting; September 22-26th, 2018, Vienna, Austria.

28. Carballo-Alvarez J, Vazquez-Molini JM, Sanz-Fernandez JC, et al. Visual outcomes after bilateral trifocal diffractive intraocular lens implantation. BMC Ophthalmol. 2015;15:26.

29. Cochener B, Vryghem J, Rozot P, et al. Visual and refractive outcomes after implantation of a fully diffractive trifocal lens. Clin Ophthalmol. 2012;6:1421–1427.

30. Alio JL, Montalban R, Pena-Garcia P, et al. Visual outcomes of a trifocal aspheric diffractive intraocular lens with microincision cataract surgery. J Refract Surg. 2013;29:756–761.

31. Vryghem JC, Heireman S. Visual performance after the implantation of a new trifocal intraocular lens. Clin Ophthalmol. 2013;7:1957–1965.

32. Sheppard AL, Shah S, Bhatt U, et al. Visual outcomes and subjective experience after bilateral implantation of a new diffractive trifocal intraocular lens. J Cataract Refract Surg. 2013;39:334–349.

33. Plaza-Puche AB, Alio JL, Sala E, et al. Impact of low mesopic contrast sensitivity outcomes in different types of modern multifocal intraocular lenses. Eur J Ophthalmol. 2016;26:612–617.

34. Martinez-de-la-Casa JM, Carballo-Alvarez J, Garcia-Bella J, et al. Photopic and mesopic performance of 2 different trifocal diffractive intraocular lenses. Eur J Ophthalmol. 2016;26:26–30.

35. Marques JP, Rosa AM, Quendera B, et al. Quantitative evaluation of visual function 12 months after bilateral implantation of a diffractive trifocal IOL. Eur J Ophthalmol. 2015;25:516–524.

36. Marques EF, Ferreira TB. Comparison of visual outcomes of 2 diffractive trifocal intraocular lenses. J Cataract Refract Surg. 2015;41:354–363.

37. Jonker SM, Bauer NI, Makhotkina NY, et al. Comparison of a trifocal intraocular lens with a +3.0 D bifocal IOL: results of a prospective randomized clinical trial. J Cataract Refract Surg. 2015;41:1631–1640.

38. Ferreira-Rios I, Zuniga-Posset K, Serna-Ojeda JC, et al. Objective and subjective results following implantation of the FineVision trifocal intraocular lens in Mexican patients. Int Ophthalmol. 2018;38:2617–2622.

39. Cochener B, Vryghem J, Rozot P, et al. Clinical outcomes with a trifocal intraocular lens: a multicenter study. J Refract Surg. 2014;30:762–768.

40. Cochener B. Prospective clinical comparison of patient outcomes following implantation of trifocal or bifocal intraocular lenses. J Refract Surg. 2016;32:146–151.

41. Bilbao-Calabuig R, Llovet-Raussell A, Ortega-Usobiaga J, et al. Visual outcomes following bilateral Implantation of two diffractive trifocal intraocular lenses in 10 084 eyes. Am J Ophthalmol. 2017;179:55–66.

42. Alfonso JF, Fernandez-Vega Cueto L, Belda-Salmeron L, et al. Visual function after implantation of a diffractive aspheric trifocal intraocular lens. Eur J Ophthalmol. 2016;26:405–411.

43. Alio JL, Kaymak H, Breyer D, et al. Quality of life related variables measured for three multifocal diffractive intraocular lenses: a prospective randomised clinical trial. Clin Exp Ophthalmol. 2018;46:380–388.

44. Kaymak H, Breyer D, Alio JL, et al. Visual performance with bifocal and trifocal diffractive intraocular lenses: a prospective three-armed randomized multicenter clinical trial. J Refract Surg. 2017;33:655–662.

45. Kim M, Kim JH, Lim TH, et al. Comparison of reading speed after bilateral bifocal and trifocal intraocular lens implantation. Korean J Ophthalmol. 2018;32:77–82.

46. Kohnen T, Titic C, Bohm M. Trifocal intraocular lens implantation to treat visual demands in various distances following lens removal. Am J Ophthalmol. 2016;161:71–77.

47. Kretz FT, Choi CY, Muller M, et al. Visual outcomes, patient satisfaction and spectacle independence with a trifocal diffractive intraocular lens. Korean J Ophthalmol. 2016;30:180–191.

48. Law EM, Aggarwal RK, Kasaby H. Clinical outcomes with a new trifocal intraocular lens. Eur J Ophthalmol. 2014;24:501–508.

49. Liu X, Xie L, Huang Y. Comparison of the visual performance after implantation of bifocal and trifocal intraocular lenses having an identical platform. J Refract Surg. 2018;34:273–280.

50. Mencucci R, Favazza E, Caporossi O, et al. Visual performance, reading ability and patient satisfaction after implantation of a diffractive trifocal intraocular lens. Clin Ophthalmol. 2017;11:1987–1993.

51. Mendicute J, Kapp A, Levy P, et al. Evaluation of visual outcomes and patient satisfaction after implantation of a diffractive trifocal intraocular lens. J Cataract Refract Surg. 2016;42:203–210.

52. Mojzis P, Kukuckova L, Majerova K, et al. Comparative analysis of the visual performance after cataract surgery with implantation of a bifocal or trifocal diffractive IOL. J Refract Surg. 2014;30:666–672.

53. Mojzis P, Majerova K, Hrekova L, et al. Implantation of a diffractive trifocal intraocular lens: one-year follow-up. J Cataract Refract Surg. 2015;41:1623–1630.

54. Postolache C, Postolache O. Comparison of refractive results with bifocal implants at Lima 809 and trifocal at Lima Tis839. Rom J Ophthalmol. 2015;59:100–102.

55. Steinwender G, Schwarz L, Bohm M, et al. Visual results after implantation of a trifocal intraocular lens in high myopes. J Cataract Refract Surg. 2018;44:680–685.

56. Yang Y, Lv H, Wang Y, et al. Clinical outcomes following trifocal diffractive intraocular lens implantation for age-related cataract in China. Clin Ophthalmol. 2018;12:1317–1324.

57. Cochener B, Concerto Study Group. Clinical outcomes of a new extended range of vision intraocular lens: International Multicenter Concerto Study. J Cataract Refract Surg. 2016;42:1268–1275.

58. Ganesh S, Brar S, Pawar A, et al. Visual and refractive outcomes following bilateral implantation of extended range of vision intraocular lens with micromonovision. J Ophthalmol. 2018;2018:7321794.

59. Hamid A, Sokwala A. A more natural way of seeing: visual performance of three presbyopia correcting intraocular lenses. Open J Ophthalmol. 2016;6:176–183.

60. Hogarty DT, Russell DJ, Ward BM, et al. Comparing visual acuity, range of vision and spectacle independence in the extended range of vision and monofocal intraocular lens. Clin Exp Ophthalmol. 2018;46:854–860.

61. Pedrotti E, Carones F, Aiello F, et al. Comparative analysis of the clinical outcomes with a monofocal and an extended range of vision intraocular lens. J Refract Surg. 2016;32:436–442.

62. Pedrotti E, Carones F, Aiello F, et al. Comparative analysis of visual outcomes with 4 intraocular lenses: monofocal, multifocal, and extended range of vision intraocular lens: International Multicenter Concerto Study. Eur J Ophthalmol. 2018;28:425–432.

63. Pilger D, Homburg D, Brockmann T, et al. Clinical outcome and higher order aberrations after bilateral implantation of an extended depth of focus intraocular lens. Eur J Ophthalmol. 2018;28:425–432.

64. Ruiz-Mesa R, Abengozar-Vela A, Aramburu A, et al. Comparison of visual outcomes after bilateral implantation of extended range of vision and trifocal intraocular lenses. Eur J Ophthalmol. 2017;27:460–465.
65. Sachdev GS, Sachdev M. Optimizing outcomes with multifocal intraocular lenses. Indian J Ophthalmol. 2017;65:1294–1300.
66. Carson D, Xu Z, Alexander E, et al. Optical bench performance of 3 trifocal intraocular lenses. J Cataract Refract Surg. 2016;42:1361–1367.
67. Esteve-Taboada JJ, Dominguez-Vicent A, Del Aguila-Carrasco AJ, et al. Effect of large apertures on the optical quality of three multifocal lenses. J Refract Surg. 2015;31:666–676.
68. Kacerovsky M. PanOptix and AT LISA tri in presbyopic surgery. Presented at European Society of Cataract and Refractive Surgeons education forum. September 2018, Vienna, Austria. Available at: http://forum.escrs.org/escrs-presentations-and-videos/panoptix-and-at-lisa-tri-in-presbyopic-surgery.
69. Average of American OSHA, Canadian OSHA and American Optometric Association Recommendations for Computer Monitor Distances. Available at www.aoa.org. 2015.
70. Plagenhoef S, Evans F, Abdelnour T. Anatomical data for analyzing human motion. Research Quarterly for Exercise and Sport. 1983;54:169–178.
71. Turgut B. Ocular Ergonomics for the Computer Vision Syndrome. Journal of Eye and Vision. 2018;1:2.
72. Lee H, Lee K, Ahn JM, et al. Evaluation of optical quality parameters and ocular aberrations in multifocal intraocular lens implanted eyes. Yonsei Med J. 2014;55:1413–1420.
73. Makhotkina NY, Nijkamp MD, Berendschot T, et al. Effect of active evaluation on the detection of negative dysphotopsia after sequential cataract surgery: discrepancy between incidences of unsolicited and solicited complaints. Acta Ophthalmol. 2018;96:81–87.
74. Apple DJ, Peng Q, Visessook N, et al. Eradication of posterior capsule opacification: documentation of a marked decrease in Nd:YAG laser posterior capsulotomy rates noted in an analysis of 5416 pseudophakic human eyes obtained postmortem. Ophthalmology. 2001;108:505–518.
75. Davison JA. Neodymium: YAG laser posterior capsulotomy after implantation of AcrySof intraocular lenses. J Cataract Refract Surg. 2004;30:1492–1500.
76. Bilbao-Calabuig R, Llovet-Osuna F, Gonzalez-Lopez F, et al. Nd:YAG capsulotomy rates with two trifocal intraocular lenses. J Refract Surg. 2016;32:748–752.
77. Alio JL, Plaza-Puche AB, Fernandez-Buenaga R, et al. Multifocal intraocular lenses: an overview. Surv Ophthalmol. 2017;62:611–634.
78. Zvornicanin J, Zvornicanin E. Premium intraocular lenses: the past, present and future. J Curr Ophthalmol. 2018;30:287–296.
79. de Vries NE, Webers CA, Touwslager WR, et al. Dissatisfaction after implantation of multifocal intraocular lenses. J Cataract Refract Surg. 2011;37:859–865.
80. Mester U, Vaterrodt T, Goes F, et al. Impact of personality characteristics on patient satisfaction after multifocal intraocular lens implantation: results from the “happy patient study”. J Refract Surg. 2014;30:674–678.