Expert Review of Ophthalmology

ISSN: 1746-9899 (Print) 1746-9902 (Online) Journal homepage: www.tandfonline.com/journals/ierl20

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To cite this article: Buckhard Dick, Eric Donnenfeld, Alice Epitropoulos , Francis Mah , Christina Leydolt , Mitchel Shultz, Mohamed Yassine , Rebeca Gonzalez , Robert Ang, Lisa Feulner , John Sheppard & Francisco J. Castro-Alonso (26 Jun 2026): Optimizing intraocular lens selection: a narrative review of the enVista and lux platforms — technologies, clinical outcomes, and patient-centered decision-making, Expert Review of Ophthalmology, DOI: 10.1080/17469899.2026.2687163

To link to this article: https://doi.org/10.1080/17469899.2026.2687163

EXPERT REVIEW OF OPHTHALMOLOGY
https://doi.org/10.1080/17469899.2026.2687163

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REVIEW

Optimizing intraocular lens selection: a narrative review of the enVista and lux platforms — technologies, clinical outcomes, and patient-centered decision-making

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ABSTRACT

Introduction: Over the past 75 years, intraocular lens (IOL) technology has evolved through innovations in materials, optics, and surgical techniques. There is a comprehensive range of IOL products available at times making the decision challenging for the surgeon and patient to choose the most suitable IOL.

Areas covered: The objective of this narrative review is to provide an overview of the enVista (monofocal, Aspire enhanced monofocal, and Envy full range vision), Lux (LuxGood monofocal, LuxSmart extended depth of focus, and LuxLife full range vision), and IC-8/ Apthera (small aperture) IOL platforms focusing on advanced/novel technologies and clinical performance to guide surgical decision-making and personalized lens selection. PubMed was searched from inception through October 2025, and studies were selected based on relevance and contribution to the objectives.

Expert opinion: No single lens type meets the needs of every patient, and the lens choice should be based on patients' anatomical and physiological characteristics, needs, expectations, and lifestyle. Considerations for selecting an IOL and advice for setting patient expectations are provided.

ARTICLE HISTORY
Received 2 March 2026
Accepted 5 June 2026

KEYWORDS
Cataract; EDOF; enhanced monofocal; intraocular lens; multifocal lens; small aperture intraocular lens

1. Introduction

Cataracts are a leading cause of vision impairment [1]. The demand for advanced intraocular lenses (IOLs) is increasing globally [1,2], in part due to an increase in the aging population; improvement in cataract surgery safety; and better access to healthcare that offer improved, customized visual outcomes and greater patient satisfaction [3]. There is a comprehensive range of IOL products available making it challenging for the surgeon and patient to choose the most suitable IOL. This review describes the latest advancements in IOLs with a focus on enVista (Bausch + Lomb) and Lux (Bausch + Lomb) IOL platform technologies and their clinical outcomes. It seeks to refine the clinical decision-making process for IOL selection, ultimately improving patient outcomes. This narrative review emphasizes practical, clinically relevant differences among the IOL platforms to support evidence-based and patient-centered selection. PubMed was searched from inception through October 2025, using the following keywords in various combinations: enVista IOL, Lux IOL, toric calculator, intraocular lens, cataract, materials, shape, haptics, and optics. Only articles having English abstracts were reviewed. Reference lists of included publications were also a source of articles. Studies were selected based on rigor (ie, randomized controlled studies prioritized over other categories) and relevance and contribution to the objectives, with a focus on articles published since 2015. Where evidence was sparse, all available peer-reviewed primary articles were included. When there was a lack of peer-reviewed data, attempts were made to locate unpublished data such as data presented at national/international meetings and published on various websites. Because this is a narrative review that involved no collection or analysis of primary data, formal ethics committee approval was not required.

2. Overview of IOL evolution

Over the past 75 years, IOL technology has evolved through innovations in materials, optics, and surgical techniques [3]. With the advent of phacoemulsification surgery in 1967 followed by foldable IOLs in 1985, small incision cataract surgery became commonplace [3]. In the early 2000s, femtosecond laser technology was available for cataract surgery, which further improved surgical precision. What was once a restorative procedure is now an opportunity for spectacle independence and improved quality of vision. The demand for increased visual customization and spectacle independence has driven the development of more advanced material and design IOL technology.

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Article highlights

- The demand for increased visual customization and spectacle independence has driven the development of more advanced material and design IOL technology.
- The mechanism of action and advantages/disadvantages of monofocal, enhanced monofocal, toric, full visual range, extended depth of focus, accommodating, and small aperture IOLs are discussed.
- This review highlights the latest advancements in IOLs with a focus on enVista (Bausch + Lomb) and Lux (Bausch + Lomb) IOL platform technologies and their clinical outcomes.
- Given the breadth of IOLs available, it is challenging for the surgeon and patient to choose the most suitable IOL.
- An expert opinion on considerations for selecting an IOL and advice for the patient are provided.

2.1. Evolutions in material

Poly-methyl-methacrylate (PMMA) was the first IOL implanted in 1949 and was the primary used material through the 1980s [4]. The material was favored for its optical clarity and inertness [5]. However, its rigidity necessitated large incisions, leading to longer recovery times and surgically induced astigmatism (SIA). PMMA IOLs are not appropriate for small incision phacoemulsification [5]. Thus, PMMA is no longer frequently used. The emergence of silicone IOLs in the mid-1970s introduced flexibility and enabled lens folding, which minimized the incision size. Silicone IOLs are biocompatible, and their surface is less adherent to lens epithelial cells [5]. Despite these benefits, early silicone lenses were associated with surface calcification and discoloration [5,6]. Silicone lenses are inappropriate for patients already have or who may require silicone oil surgical vitreous replacement [7]. Hydrophilic acrylic lenses (also called hydrogel lenses) were developed in the 1980s; their high-water content lowers the refractive index and increases foldability, but they have higher rates of posterior capsule opacification (PCO). Hydrophobic acrylic lenses emerged in the early 1990s and are the most widely used material today.

PCO is the most common postoperative complication following cataract surgery [8,9]. The water content of the IOL, together with the posterior edge design (discussed in the following section), has been reported to influence both the development and severity of PCO [5,10]. Hydrophobic acrylic materials exhibit greater adhesiveness to the capsule compared to hydrophilic acrylics, PMMA, or silicone [11,12]. In addition, the water content in certain hydrophobic acrylic IOLs has been implicated in the formation of glistenings—visible microvacuoles resulting from water ingress into the bulk polymer [5], which may increase over time and negatively affect visual function [13,14].

2.2. Design innovations: IOL shape and haptics

The square/sharp posterior edge was designed to decrease the incidence of PCO by providing a barrier to migrating lens epithelial cells [4,10]. There are variations in what is defined as square edges, with some IOLs having flat sides but round corners [9]. A systematic review concluded that sharp-edged IOLs have less PCO formation compared with round-edged IOLs [8]. However, the square edge is associated with a higher incidence of dysphotopsia than a round edge [15,16].

The need for haptic fixation to prevent IOL decentration was first recognized with the implantation of the initial IOL in 1949 [3]. Since then, haptic designs have evolved, with the most common posterior IOL configurations including the C-loop, J-loop, plate and 4-haptic designs [15]. Haptic architecture plays a critical role in ensuring the rotational stability of toric lenses and in maintaining the centration of IOLs [4].

2.3. Advances in optics

Spherical aberration (SA) occurs when peripheral and axial light rays come from different foci, which causes images to appear blurred, resulting in loss of contrast sensitivity that may affect visual function, especially in poor light conditions and with larger pupils [17,18]. SA is positive when peripheral light rays focus anterior to the paraxial rays [18]. The normal human cornea typically exhibits a mean SA of approximately +0.28 µm [19]. Traditional IOLs incorporated positive spherical surfaces in their design, which was additive to the cornea and induced additional positive SA. This additive effect compounded the corneal SA, degrading the overall quality of the retinal image [18], an issue that was not well recognized at the time, but was later identified as a limitation contributing to reduced contrast sensitivity and night vision [20]. In contrast, aspheric IOLs employ an aspheric surface on the optic to minimize this effect. These lenses may be neutral (not inducing additional SA) or negative, providing partial or complete cancellation of the innate corneal SA. Some clinical studies have shown that aspheric IOLs improve contrast sensitivity and enhance visual quality under mesopic conditions [4,20–23]. However, other studies show no differences in mesopic or photopic contrast sensitivity or quality of vision between aspheric and spherical IOLs [24,25] or that aspheric and spherically neutral IOL designs may negatively affect uncorrected near vision by reducing vertical coma aberration, which enhances depth of focus [26].

2.3.1. Monofocal and enhanced monofocal IOLs

Despite advances in IOL optics, monofocal IOLs remain the most commonly implanted type of IOL and most health insurance companies pay for this type of IOL [27,28]. Monofocal IOLs have one focal point to restore far vision and correct any associated defocus (e.g. myopia or hyperopia) without eyeglasses. Patients will still need spectacles for reading or for correction of astigmatism. Monofocal lenses can be spherical or aspherical. Some patients, particularly high myopes, may choose to receive monofocal lenses calibrated to reading distance, thereby choosing to wear glasses for distance function.

Enhanced monofocal IOLs were innovated in an attempt to meet the growing desire for spectacle-free intermediate vision without the dysphotopsias and loss of contrast associated with multifocal or extended depth of focus (EDOF) lenses [21]. These enhanced monofocal IOLs provide distance visual acuity (VA) similar to a monofocal IOL, but also provide enhanced intermediate functional vision through a continuous extended focal range.

2.3.2. Toric IOLs

A retrospective study of 17,152 eyes concluded that low levels of residual astigmatism were visually significant and affected patient satisfaction [29]. Thus, even small amounts of astigmatism should be considered during surgical planning. Although astigmatism <0.5 D may not noticeably degrade VA, against the rule cylinder is generally more optically significant than with the rule astigmatism [30]. In the early 1990s, toric IOLs were developed to neutralize preexisting corneal or surgically induced astigmatism and produce better uncorrected distance visual acuity (UDVA) compared with non-toric monofocal IOLs [31,32]. Toric IOLs can allow more reproducible astigmatism correction than corneal relaxing incisions performed after implantation of a non-toric monofocal lens [32]. The majority of lens models are now available in a toric version.

2.3.3. Presbyopia-correcting IOLs

The first multifocal IOLs entered the market in the early 2000s (toric versions in 2008) and were originally bifocal (providing near and distance correction). However, the demand for intermediate vision has increased with the rise of hand-held electronic devices and computer use. This need paved the way for multifocal IOL design that split the light into two or more focal points. Multifocal vision is achieved via refractive or diffractive design concepts. The first multifocal IOLs had a refractive design, using different radii of curvature to create multiple foci [28]. Diffractive IOLs use diffractive steps instead of changes in the curvature to create multifocality. A meta-analysis of clinical studies concluded that diffractive and refractive multifocal IOLs have a similar halo incidence rate [28]. Apodized IOLs have a gradual reduction of step height toward the lens periphery to direct more light to the distance focus, reduce visual disturbances, and improve contrast in distance VA. This design reduces photic phenomena (glare/halos) and improves contrast sensitivity [28].

2.3.3.1. Full depth of field IOLs. Full visual range IOLs are a type of multifocal IOL that creates functionally useful vision from far through intermediate and up to near [33]. ISO 11979–7:2024 classifies full visual range IOLs as having best corrected distance visual acuity (CDVA) of ≤0.1 logMAR, distance corrected intermediate visual acuity (DCIVA) at 66 cm of ≤0.2 logMAR, DCNVA at 40 cm of ≤0.2 logMAR, and a total range of focus of ≥2.5 D at 0.2 logMAR acuity [33,34].

2.3.3.2. Extended depth of focus (EDOF) IOLs. The principle behind EDOF IOLs is to create a single elongated focal point to enhance the depth of focus or range of vision thereby improving intermediate and some near vision with minimal impact on distance vision and while allowing less dysphotopsias and loss of contrast than a multifocal IOL. The American National Standards Institute (ANSI-Z80.35–2018) has issued a defined EDOF IOL requirements as (1) statistical superiority over the control on mean, monocular photopic distance corrected intermediate visual acuity at 66 cm; (2) ≥0.5 D greater monocular photopic negative lens induced distance-corrected depth of focus compared to a monofocal control at 0.2 logMAR; (3) median monocular photopic DCIVA at 66 cm of ≥0.2 logMAR; and (4) mean monocular photopic CDVA statistically noninferior to the control using a 0.1 logMAR non-inferiority margin [35] (EDOF IOL definitions were derived from a control cohort of monofocal IOLs [35].). As with multifocal IOLs, the elongated focus can be achieved with refractive, diffractive, or pinhole optic profiles. EDOF lens performance may be pupil-dependent [36]. Thus, pupil dynamics rather than nominal lens power can have a larger effect on optical quality [37].

2.3.3.3. Accommodating IOL. An accommodating IOL addresses presbyopia by employing the eye's natural accommodative effort to increase dioptric power and change focus from distance to near [38]. As the ciliary muscle contracts, the increase in vitreous pressure moves the IOL forward and/or changes its tilt/shape. A limitation of accommodating IOLs is that variations in capsular bag size, fibrosis, centration, medications with anticholinergic side effects, and fibrotic capsular bag contractions can impact the lens's ability to accommodate [38]. The Bausch + Lomb Crystalens was the first accommodating IOL approved in the United States (in 2003) [39].

2.3.3.4. Small aperture lens. Small aperture IOLs, also called pinhole IOLs, use an optical principle that is neither refractive nor diffractive but rather blocks light rays that do not pass through the central region of the lens. The depth of focus increases as aperture diameter decreases and can be employed to improve quality of vision in patients with irregular or highly aberrated corneas [40,41].

2.4. IOL classification

There has been a call to internationally standardize the IOL classification system beyond the optical design [33,42]. Optical design classification may not accurately predict functional outcomes [33]. An evidence-based functional classification enhances the clinician's understanding of an IOL's function to improve selection and ultimately patient satisfaction. The Congress of the European Society of Cataract Surgery (ESCRS) Functional Vision Working Group proposed a global standard based on functional outcomes (ie, visual performance and daily living) [33]. Table 1 provides the standard classification of the IOLs described in this review.

2.5. Advantages and disadvantages of different IOL optics

Multifocal IOLs provide a broader range of vision and greater spectacle independence across all distances compared with EDOF IOLs. However, EDOF lenses generally maintain better contrast sensitivity [43] and are associated with a lower incidence of dysphotopsias [44,45]. Compared with monofocal IOLs, multifocal and EDOF IOLs have similar distance vision, superior near vision, and provide greater spectacle independence [15,21,46]. Monofocal IOLs have less glare and halos compared with multifocal and EDOF IOLs, and better mesopic contrast sensitivity especially at higher spatial frequencies

Table 1. Standard classification of IOLs based on ESCRS functional vision working group.

Platform	IOL	Standard classification
enVista	enVista MX60/MX60E/MX60EE enVista Toric MX60T/MX60ET	Monofocal
	enVista Aspire[a] enVista Aspire Toric	Enhanced monofocal
	enVista Envy[b] enVista Envy Toric	Full range vision
Lux	LuxGood LuxGood Toric	Monofocal
	LuxSmart[c] LuxSmart Toric	EDOF
	LuxLife[d] LuxLife Toric	Full range vision

Abbreviations: EDOF = extended depth of focus.
[a]enVista Aspire showed a monocular defocus curve of approximately 1.50 D depth of focus at a 0.2 logMAR CDVA threshold [71].
[b]The enVista Envy defocus curve demonstrated a full range of functional vision of 0.2 logMAR (20/32) or better across a 4.0 D defocus range from +1.0 to −3.0 D [82].
[c]The LuxSmart defocus curve showed an approximate 0.2 logMAR or better VA range between −1.75 D and +0.75 D [95].
[d]LuxLife demonstrated a binocular defocus curve with a continuous depth of field exceeding 3.0 D at a threshold of 0.2 logMAR of CDVA [102].
Note: Some publications describe IOLs by functional classification using depth of field (DOFi), which is also known as range of field. However, this table uses the standard classification based on the ESCRS criteria [33]. Alternately, functional classification uses standardized visual performance thresholds (CDVA, DCIVA, DCNVA, and total range of focus) to categorize IOLs [33].

[21,46]. Thus, multifocal and EDOF lenses can provide the desired range of vision (including intermediate vision); however, persistent unwanted photic phenomena, such as halos and loss of contrast, can adversely affect patient satisfaction, and have been known to cause IOL explantation and exchange [28,47].

Residual refractive cylinder can be visually significant even at approximately 0.5 D [29,48]. Toric IOLs are more effective than limbal relaxing incisions at the time of cataract surgery for predictably and sustainably correcting small amounts of corneal astigmatism at the time of surgery [32,49]. In the case of toric IOLs, achieving optimal visual outcomes relies on accurate, repeatable biometry and keratometry, a clear understanding of the expected magnitude of SIA, and maintaining rotational stability and centration. These factors, when well-managed, support highly predictable refractive results [50]. Notably, rotational stability is even more critical for multifocal toric IOLs than for a monofocal toric IOLs [50].

An advantage of an enhanced monofocal IOL is that it provides distance VA comparable to a standard monofocal IOL while inducing minimal dysphotopsia, and incorporates enhanced optical design to extend the depth of focus, thereby improving intermediate vision [51]. Since it is a monofocal lens, some countries may not consider it a premium lens; thus, it may be a more cost-effective option for patients desiring intermediate vision.

The advantage of small aperture IOLs is that they reduce higher order aberrations by limiting peripheral light, which can benefit eyes with irregular and highly aberrated corneas; however, proper centration is needed for optimal performance [40]. The disadvantage is that the reduced aperture limits the amount of light entering the eye, which could cause dimming particularly in scotopic conditions. Additionally, patient selection must consider pupil size, which requires a pharmacologically dilated pupil size of at least 7.0 mm. The technique for YAG capsulotomy differs from standard IOLs to avoid disrupting the central aperture.

2.6. Biometric and computational advances

When choosing an IOL, refractive accuracy depends on precise preoperative biometry (axial length, keratometry, and anterior chamber depth) and accurate effective lens position estimation. Improvements in power calculations help reduce residual refractive error that could compromise patient satisfaction and postoperative VA [29,52]. An unstable and hyperosmolar tear film from dry eye disease can prevent accurate keratometric and axial length measurements leading to refractive surprises; therefore, dry eye should be treated prior to obtaining final biometric measurements [53,54]. There are at least 29 different power calculation formulas, including newer artificial intelligence (AI) based formulas with the Hill RBF among the pioneers [55,56]. A systematic review reported that the most precise formulas today are the Barrett Universal II (a vergence formula) and the Kane and PEARL-DGS (AI-based formulas) [55]. There are also special formulas for astigmatic eyes to determine toric power and alignment axis. Current understanding is that total corneal astigmatism arises from both the anterior and posterior cornea, whereas older toric calculators accounted for anterior corneal astigmatism [57]. For example, the Emmetropia Verifying Optical (EVO) v2.0 Toric Calculator uses a vergence-based formula that incorporates the eye's optical dimensions, effective lens position, and specific IOL geometry. This approach has been shown to outperform traditional toric calculators and provides results comparable to the Barrett Toric calculator [57,58]. The Bausch + Lomb Toric Calculator incorporates the EVO Toric Calculator, which combines the surgeon's SIA input with measured preoperative anterior corneal astigmatism, predicted posterior corneal astigmatism, effective lens position, and other relevant factors to calculate the eye's total corneal astigmatism. Based on this calculation, the calculator recommends the appropriate toric cylinder power needed to correct the astigmatism.

2.7. enVista platform

The enVista platform is made of a hydrophobic, glistening-free material with broad modified C-loop step- vaulted haptics and UV cutoff of 389 nm at 10% transmittance [59]. enVista lenses are packaged in a prehydrated state with physiologic saline. The material has been shown to be glistening-free up to 3 years post-implantation in patients of European and Asian descent [60–62]. The haptics contain a triangular fenestration base to prevent transfer of stress between the haptic and optic [60]. The enVista haptic design maximizes the contact angle against the capsular bag to provide stability. enVista IOLs have a continuous 360° posterior square edge to help prevent PCO. In a 3-year study of 245 eyes, the incidence of PCO requiring Nd:YAG capsulotomy was 2.2% [62]. Optical bench data demonstrate that the enVista material is 25-times harder

than a traditional hydrophobic acrylic, making it scratch resistant [63]. The enVista platform is available in monofocal, enhanced monofocal (also called monofocal plus), and full visual range versions, all with toric options. An EDOF version is now in FDA trials.

To improve injectability and unfolding efficiency Bausch + Lomb made a modification to the enVista material by slightly increasing the P(EG)PEA (poly (ethylene glycol) phenyl ether acrylate) and decreasing the styrene content [64]. As described at the Association for Research in Vision and Ophthalmology (ARVO) annual meeting, this enhanced model is called MX60E/MX60ET and unfolds 4- to 5-times faster than the parent material and is less sensitive to environmental temperature variations [65].

2.7.1. enVista one-piece hydrophobic acrylic monofocal IOL (models MX60/MX60T and MX60E/MX60EE/MX60ET/MX60ETE)

Model MX60/MX60T is the original enVista monofocal IOL and was first implanted in 2010. The aspheric design has uniform lens power from center to edge with neutral SA, which produces better image quality because it is more resistant to typical amounts of tilt, decentration, and defocus [50,64]; better contrast sensitivity compared with a spherical lens [23,66]; and less sensitivity to aberrations caused by decentration [67]. enVista monofocal IOLs demonstrated favorable performance and safety in clinical studies. Together, data from prospective multicenter studies and an observational study demonstrate that the MX60 and MX60T models deliver favorable refractive and visual outcomes [61,64,68]; with few to no reports of photophobia, glare, halos, or other visual disturbances [68]. They show high rotational stability (≤5°at Day 1 and between Day 1 and Day 120–180) [60,64,68]; similar mean decentration and tilt at each visit [60]; and consequently, good refractive stability [60]. A study comparing misalignment and rotation of monofocal toric IOLs (the Lentis LT [Oculentis, Berlin, Germany], enVista, and AcrySof IQ [Alcon Laboratories, Fort Worth, TX]) and one multifocal toric IOL (AcrySof IQ ReSTOR; Alcon Laboratories) implanted in 91 patients revealed that the enVista lens was the most stable IOL at 1-hour post-surgery, with 90.5% of eyes exhibiting <5° of rotation at 30 days postoperative [50]. No glistenings were reported, and adverse events (AEs) were infrequent [60,61]. enVista Toric MX60T/MX60ET/MX60ETE are available for a full range of toric cylinders (Table 2).

2.7.2. enVista Aspire and Aspire Toric enhanced monofocal IOL

The enVista Aspire enhanced monofocal IOL was approved by the FDA in 2023. It was developed to provide a continuous depth of focus from distance to intermediate without compromising distance vision. According to the company website, the Aspire IOL uses an optical modification of the posterior aspheric surface to create a small continuous change in IOL power within the central 1.5 mm diameter slightly broadening the depth of focus [69]. An optical bench study, presented at the ARVO annual meeting, demonstrated that images obtained with the Aspire lens had high contrast at both far and intermediate distances, whereas the control lens (MX60E) had best contrast at distance only [70]. enVista Aspire Toric is available for ultralow cylinder (Table 2).

The safety and efficacy of the enVista Aspire/Aspire Toric IOL have been evaluated in prospective and retrospective studies. The IOL delivered good UDVA, CDVA, and uncorrected intermediate visual acuity (UIVA) as demonstrated in peer-review publication and ASCRS meeting presentations [71–75]. enVista Aspire showed a monocular defocus curve of approximately 1.50 D depth of focus at a 0.2 logMAR CDVA threshold [71] Eyes targeted with a slight myopic offset of >0.75 D achieved UIVA of 20/30 or better and 88.2% had uncorrected near visual acuity (UNVA) of 20/40 or better postoperatively, as presented at the ASCRS annual meeting [76]. In a survey of clinicians, presented at the ASCRS annual meeting, providers were very satisfied and rated the Aspire and the Aspire Toric IOL a 9 or 10 out of 10 for qualities such as centration, glistening-free material, rotational stability, ease of intraoperative manipulation, and IOL material, as well as for outcomes (rate of postoperative complications or AEs, distance contrast sensitivity, rate of visual disturbances, distance vision, target vs achieved refractive outcome, astigmatism correction, and overall performance) [77]. No AEs were reported according to presentations at the ASCRS annual meeting [73–75]. Taken together these studies demonstrate that patients who are concerned about unwanted photic phenomena or are not ideal candidates for presbyopia-correcting IOLs can benefit from the enVista Aspire, which provides good distance and intermediate vision and some functional near vision.

Table 2. Cylinder power ranges for each toric IOL.

Toric IOL	IOL plane	Corneal plane
enVista Toric MX60T/ MX60ET/ MX60ETE	+1.25 D, +1.50 D, +2.00 D, +2.50 D, +3.00 D, +3.50 D, +4.25 D, +5.00 D, +5.75 D	+0.90 D, +1.06 D, +1.40 D, +1.76 D, +2.11 D, +2.45 D, +2.98 D, +3.50 D, +4.03 D
enVista Aspire Toric[a]	+0.90 D, +1.25 D, +1.50 D, +2.00 D, +2.50 D, +3.00 D, +3.50 D, +4.25 D, +5.00 D, +5.75 D	+0.64 D, +0.90 D, +1.06 D, +1.40 D, +1.76 D, +2.11 D, +2.45 D, +2.98 D, +3.50 D, +4.03 D
enVista Envy Toric[a]	+0.90 D, +1.25 D, +1.50 D, +2.00 D, +2.50 D, +3.00 D, +3.50 D, +4.25 D, +5.00 D, +5.75 D	+0.64 D, +0.90 D, +1.06 D, +1.40 D, +1.76 D, +2.11 D, +2.45 D, +2.98 D, +3.50 D, +4.03 D
LuxSmart Toric	+0.75 D, +1.00 D, +1.50 D, +2.25 D, +3.00 D, +3.75 D, +4.50 D, +5.25 D, +6.00 D	+0.50 D, +0.68 D, +1.03 D, +1.55 D, +2.06 D, +2.57 D, +3.08 D, +3.60 D, +4.11 D
LuxLife Toric	+0.75 D, +1.00 D, +1.50 D, +2.25 D, +3.00 D, +3.75 D, +4.50 D, +5.25 D, +6.00 D	+0.50 D, +0.68 D, +1.03 D, +1.55 D, +2.06 D, +2.57 D, +3.08 D, +3.60 D, +4.11 D

Abbreviations: D = diopters, NA = not available.
[a]The 0.90 D IOL plane (+0.64 corneal plane) IOL is only available out of the United States.
[b]Corneal-plane equivalents are not available for the Lux platform toric IOLs.

2.7.3. enVista Envy/Envy Toric full visual range IOL

enVista Envy/Envy Toric is considered a full visual range IOL that was approved by the FDA in 2024. This one-piece hydrophobic acrylic ultraviolet-absorbing IOL has low add powers of +1.6 D for intermediate and +3.1 D for near [78]. According to a recent white paper, the Envy/Envy Toric uses novel diffractive technology called ActiveSync to reduce light scatter and visual disturbances while maintaining image contrast. Specifically, the apodized diffractive design has smaller steps that gradually decrease in height toward the periphery enabling balanced light distribution for distance, intermediate, and near vision [79]. Similarly to enVista Aspire Toric, enVista Envy Toric is available for ultralow cylinder (Table 2).

The safety and efficacy of enVista Envy have been confirmed in two prospective, large-scale, multicenter, randomized controlled trials in which patients received bilateral enVista Envy or monofocal control [80,81]. In both studies enVista Envy was noninferior to monofocal control in CDVA and statistically superior for binocular UIVA and UNVA [80,81]. Also, 89.1% of Envy patients demonstrated binocular uncorrected VA of 20/32 or better at all distances (far, intermediate, and near) [80]. This is consistent with the defocus curve, which demonstrated a full range of functional vision of 0.2 logMAR (20/32) or better across a 4.0 D defocus range from +1.0 to −3.0 D, as presented at ESCRS [82]. The binocular contrast sensitivity was similar to that of the monofocal control [82]. Reports of glare, hazy vision, blurred vision distortion, double vision, fluctuating vision, difficulty focusing, and difficulty judging distance/depth were infrequent and nearly all patients were never or occasionally bothered by halos, glare, or starbursts at final follow-up [81,83]. Postoperatively, 92.7% of Envy patients were satisfied with their near vision, and 91.7% did not require spectacles for near-vision tasks at final follow-up [81].

2.8. Lux platform

The Lux platform consists of a hydrophobic material that incorporates a violet light filter and can be inserted through a small incision (≥2.2 mm). It provides protection from UV light with a wavelength cutoff (at 10% of transmittance) at approximately 375–400 nm [84–86]. The platform has an aberration-free aspheric design with a continuous 360°square edge to reduce PCO by preventing epithelial cell migration under the IOL. Lux IOLs have a single piece, with a 4-point fixation haptic design that provides good centration and rotational stability [87–89]. The orientation markings are located at the top right and bottom left near the optic edge to facilitate visualization. Lux IOLs are only available in a preloaded injection system (the DUAL Inserter; Medicel, Altenrhein, Switzerland), that offers either push or screw-type injection. The Lux platform is available in most countries/regions outside of the United States.

2.8.1. LuxGood/LuxGood Toric (monofocal)

The LuxGood monofocal IOL has neutral SA with uniform power across the aspheric optic so that the lens is more tolerant to decentration and tilt than lenses with negative SA [37].

2.8.2. LuxSmart/LuxSmart Toric (EDOF)

LuxSmart features 'pure refractive optics' technology with no diffractive profile across the optic. The LuxSmart IOL has an asphericity modulation design in the central 2 mm, which induces a combination of fourth and sixth-order SA of opposite signs to elongate the focus, this feature is not present in LuxGood. The peripheral zone has a refractive aspheric surface [37,90]. According to the manufacturer, there is a patented transition zone designed to smoothly decrease optic vergence from the center to the periphery. This transition zone helps control fourth- and sixth-order SAs and directs light rays such that none fall outside the functional range of vision, and therefore. LuxSmart toric is available for ultralow cylinder offering a cylinder power range from +0.75 D to +6.00 D.

The efficacy and safety of LuxSmart have been demonstrated relative to monofocal control (Akreos IOL, Bausch + Lomb), as well as in observational studies. LuxSmart was more effective at achieving DCIVA, UIVA, and UNVA than the control, without increasing the risk of unwanted photic phenomena such as halos or starbursts [91,92], and in a 'real-world setting' patients had significant improvements in distance, intermediate, and near vision [93] Photopic and mesopic contrast sensitivity was lower with LuxSmart than with the monofocal control [92,94]. The defocus curve showed an approximate 0.2 logMAR or better VA range between −1.75 D and +0.75 D [95]. Patients with LuxSmart compared with monofocal control or baseline reported high satisfaction with daily activities including reading and computer use [91,93]. Also, it was well tolerated and effective for distance and intermediate vision with minimal optical side effects when implanted unilaterally [95]. Bilateral implantation of LuxSmart Toric was evaluated in 2 prospective studies ($n = 44$ eyes and $n = 26$ eyes), which reported favorable visual outcomes (CDVA, DCIVA, and DCNVA), rotational stability ≤ 5°, and 90.9% of patients were very or fairly satisfied with their vision [96,97]. The 2 studies assessed contrast sensitivity using sine-wave gratings. One found that binocular photopic and mesopic testing at 4–6 months showed reduced sensitivity at higher spatial frequencies and under mesopic conditions, while remaining good in low light [97]. The other reported that monocular photopic contrast sensitivity at 3 months was near normal at high spatial frequencies and within the normal range across all frequencies [96]. Although LuxSmart was not designed to provide full spectacle independence, it has been evaluated with monovision or mini-monovision strategy [98]. Patients reported good distance, intermediate, and near vision, although many patients still had spectacle dependence for near tasks and were not satisfied with near vision. Only 25% of patients reported frequent glare and halos.

2.8.3. LuxLife/LuxLife Toric full range vision IOL

LuxLife was designed to provide a continuous full range of vision from distance to near. Like LuxSmart, it uses pure refractive optics with no diffractive profile across the entire optic. It has a 2 mm central zone with a + 3.40 D near addition

that induces fourth and sixth order SAs of opposite signs to enhance the range of vision from distance through intermediate to near [85]. The central zone transitions to provide +2.20 D intermediate addition, and then merges to a monofocal periphery for distance [85]. According to the manufacturer, the patented transition zones of LuxLife change the direction of light rays every 5 µm to redirect rays out of intermediate foci. Optical bench studies indicate that LuxLife is less sensitive to decentration than PanOptix (Alcon Laboratories), FineVision (BVI Medical), or Tecnis Synergy (Johnson & Johnson Vision) [99]. It is less sensitive to tilt than FineVision and similar in tilt sensitivity to PanOptix and Tecnis Synergy [99]. LuxLife toric is available for ultralow cylinder (Table 2).

Results from the first clinical study (prospective, multicenter) of LuxLife have been presented at ophthalmology meetings. LuxLife had noninferior CDVA to the monofocal group and had better UIVA and UNVA [100,101]. According to patient-reported outcomes, 81% of the LuxLife group compared with 13% of the monofocal group were spectacle-free at all distances and 83% had no difficulty reading a newspaper [101,102]. LuxLife demonstrated a binocular defocus curve with a continuous depth of field exceeding 3.0 D at a threshold of 0.2 logMAR of CDVA and exhibited reliable rotational positioning and centration at 6 months [102]. There was no significant difference between groups in the incidence of halos, though the LuxLife group reported more glare. Both IOLs had a similar safety profile. The authors concluded that bilateral LuxLife provided full range of vision and improved quality of life for daily tasks without hinderance of photic phenomena.

3. Conclusion

It is important that patients receive the most appropriate intraocular lens for their individual visual needs and specific anatomy. Surgical precision, accurate IOL power calculation, effective astigmatism correction, selection of IOLs that minimize dysphotopsia and PCO, and consideration of comorbidities (ie, retinal disease, dry eye, and post-refractive surgery) and patient anatomy (ie, pupil size), are all needed to successfully meet patient postoperative expectations. The enVista and Lux IOL platform technologies provide a full range of offerings to meet patient needs and clinician comfort. Although much of the evidence on these IOL platforms comes from non–peer-reviewed sources, this should be viewed not as a limitation of this narrative review but as a consolidated summary of the most current research on emerging technologies.

4. Expert opinion

4.1. Considerations for selecting an IOL

No single lens type meets the needs of every patient, and the lens choice should be based on the patient's anatomical and physiological characteristics, needs, expectations, and lifestyle. Having several platforms with emerging technologies facilitates individualized care but it can be difficult deciding which patient should get which lens. Table 3 compares the key design and material features of the enVista and Lux IOL platforms.

The surgeon should ascertain the patient's predominant visual needs by inquiring about work and recreational activities. Intermediate vision may be integral to the patient's lifestyle and should be supported by the chosen premium IOL. If spectacle independence for reading is a priority, a full range vision lens with sufficient near add may be preferred. EDOF lenses can provide strong intermediate vision for patients who work long hours at the computer and would like to have good distance vision for driving at day and night with minimal photic phenomena. When both near and intermediate vision are important, a full range vision IOL may offer the best balance. However, during the preoperative consultation, the patient must be made aware of the trade-off between having spectacle-free vision at intermediate and near vision and the possibility of unwanted photic phenomena and decreased contrast sensitivity.

The patient's age, personality, and ocular health history should be considered. Halos or glare at night may pose a hazard for older patients who still drive, so purely refractive (monofocal), enhanced monofocal, or EDOF lenses may be preferable. Patients with dementia may have difficulty with the neuroadaptation required for lenses such as pinhole or multifocal IOLs. Patients with retinal comorbidities who desire a multifocal IOL may be better suited with an EDOF or enhanced monofocal IOL. A patient with an easygoing nature and a willingness to compromise will typically be satisfied with the outcome of a multifocal IOL. In contrast, patients who are hypercritical will sometimes be more difficult to satisfy, and the limitations of every lens should be thoroughly explained. Similarly, patients who have had prior refractive surgery (post-refractive patients) have higher expectations because they have experienced spectacle-free vision following ocular surgery. These patients may not be satisfied with a monofocal IOL. EDOF and multifocal IOLs can be considered after a thorough evaluation of the corneal aberrations induced by the prior corneal refractive surgery.

Table 3. Comparison of features of the IOL platforms.

	enVista platform	Lux platform[a]
Haptic design	C-loop	4 haptics
Optical filter	UV-only filter (389 nm at 10% transmittance)	UV-only filter models (375 to 400 nm) and violet light filtering models (400 to 440 nm)
Glistening-free	Yes	Yes
Available Lens Types	Monofocal, enhanced monofocal, full range of vision. Toric versions available.	Monofocal, EDOF, full range of vision. Toric versions available.
Delivery system	Preloaded single-use disposable inserter	Preloaded disposable dual inserter (push or screw)

[a]Currently not available in the United States.

Both lens predictability and surgeon comfort are important factors to consider after discussing the patient's lifestyle and visual needs. When discussing IOL options with the patient, it helps to describe exactly what can be delivered: (1) distance + intermediate vision (2) distance + intermediate + near vision, or (3) distance vision only. This approach helps temper expectations. Some surgeons are not comfortable with the additional work-up required for multifocal IOLs. The advent of enhanced monofocal IOLs makes it easier for surgeons to provide patients with a greater range of vision while allowing the surgeon to remain within their individual comfort zone.

4.2. Advice to give patients

With each lens type there are trade-offs between VA, unwanted photic phenomena, and spectacle independence. Each person must balance their own preferences with their ocular physiology and any comorbidities. There is no one-size-fits-all solution. Ultimately patient satisfaction is as important as the surgical outcome. Set expectations by informing the patient that enhanced monofocal, EDOF, or multifocal IOLs will increase spectacle independence, but they may not be completely spectacle-free. It may help to tell patients receiving a full-range vision IOL that their vision may improve over time due to neuroadaptation, and that good lighting may still be needed for reading. Understand that early complaints of negative dysphotopsia or edge glare may be due to the incision itself, and explain that the dysphotopsia may resolve with healing. Emphasize to the patient the importance of optimizing the ocular surface (ie, treating dry eye) before cataract surgery to improve outcomes [103], and inform the patient of the need to be diligent in following their dry eye treatment regimen. Patients who are made aware of a dry eye diagnosis prior to surgery are more accepting of treatment [104].

4.3. Future directions

Future innovation will likely focus on optimizing contrast sensitivity and minimizing dysphotopsia while maintaining an expanded range of vision tailored to patient needs.

Funding

The manuscript was funded by Bausch and Lomb.

Declaration of interests

RA has financial disclosures with Acevision, Alcon, Bausch + Lomb, BVI, Glaukos, Hoya, Spyglass, Staar Surgical, Teclens, and Vialase. FJC-A has no financial disclosures. BD is a consultant for Bausch + Lomb; ED is a consultant to Bausch + Lomb and Johnson & Johnson Surgical Vision. AE is a consultant and speaker for Bausch + Lomb. LF is a consultant and speaker for Bausch + Lomb. RG is an employee of Bausch + Lomb. CL has received a grant/research support from Bausch + Lomb. FM is a consultant and speaker for Bausch + Lomb. JS is a consultant and speaker for Bausch + Lomb. MS is a consultant and speaker for Bausch + Lomb. MY is an employee of Bausch + Lomb. The authors have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript apart from those disclosed.

Reviewer disclosures

Peer reviewers on this manuscript have no relevant financial or other relationships to disclose.

Data availability statement

The data that support the findings of this study are openly available in the public domain including PubMed and www.bauschsurgical.com.

AI-based tools and technologies

The authors declare that no generative AI tools were used in the preparation of this manuscript.

Acknowledgments

Heather S. Oliff, PhD (Science Consulting Group, LLC) provided medical writing assistance funded by Bausch + Lomb.

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