



Contrast Sensitivity in Patients Implanted with Acunex Vario and LuxSmart Extended Depth-of-Focus Intraocular Lenses: A Review

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Received: 11 September, 2025 | Accepted: 19 September, 2025 | Published: 08 October, 2025

Citation: Boryana Irinkova, Iva Petkova, Irina Kuneva, (2025). Contrast Sensitivity in Patients Implanted with Acunex Vario and LuxSmart Extended Depth-of-Focus Intraocular Lenses: A Review, J. Clinical Case Reports and Clinical Practice1(3): dx.doi.org/CCRCP/PP.0011

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Abstract

Purpose: To review contrast sensitivity outcomes in patients implanted with two non-diffractive extended depth-of-focus (EDOF) intraocular lenses (IOLs)—Acunex Vario (Teleon) and LuxSmart (Bausch + Lomb)—and to contextualize these findings within the broader EDOF literature.

Methods: A narrative review of prospective and comparative studies was conducted, with focus on contrast sensitivity outcomes, optical design rationale, and patient satisfaction. Findings were compared with monofocal and trifocal IOLs.

Results: Both Acunex Vario and LuxSmart preserved contrast sensitivity at levels close to monofocals, with only mild reductions at higher spatial frequencies or under mesopic conditions. Comparative studies show no significant difference between the two lenses, though Acunex Vario may provide slightly stronger distance performance and LuxSmart slightly better intermediate contrast under photopic conditions. Patient satisfaction is consistently high, with low rates of halos and glare. In broader context, EDOFs outperform diffractive multifocals in contrast sensitivity but provide less near acuity.

Conclusion: Acunex Vario and LuxSmart offer a balanced compromise between extended range of vision and preservation of image quality. Careful patient selection remains essential, with ideal candidates being those prioritizing distance and intermediate vision while accepting the possible need for near spectacles.

Keywords: contrast sensitivity, extended depth-of-focus, intraocular lens, acunex vario, luxsmart, cataract surgery

Introduction

EDOF intraocular lenses (IOLs) are a relatively new option in cataract and presbyopia surgery. They are designed to bridge the gap between monofocals and multifocals: extending functional vision while avoiding common drawbacks like halos or reduced contrast sensitivity. Instead of creating multiple foci, EDOF lenses extend a single elongated focal zone to offer continuous functional vision across far and intermediate distances while reducing the risk of disturbing photic phenomena [1–3]. The American Academy of Ophthalmology Task Force recognizes EDOF lenses as a distinct category, noting their potential to improve intermediate vision with fewer visual disturbances than multifocals [15]. Among the non-diffractive EDOFs, Acunex Vario (Teleon) and LuxSmart (Bausch + Lomb) stand out as distinct designs sharing the goal of expanding the range of vision while preserving optical quality. Both have shown encouraging clinical outcomes, but because they rely on different optical strategies, it is important to understand how they compare, especially in terms of contrast sensitivity—a key determinant of functional vision in real life.

Background on Lens Design

The Acunex Vario (Teleon) is made from hydrophobic acrylic designed to minimize glistenings and has a 360° posterior edge to reduce capsular opacification. Its optical profile uses a segmental add power (+1.50 D) to expand the depth of focus while preserving image quality, to mimic the clarity of monofocals. The goal is to maintain monofocal-like distance quality while extending intermediate range and minimizing halos and glare [4]. LuxSmart, in contrast, uses an aspheric central optic engineered with higher-order spherical aberrations. It combines fourth-order and sixth-order aberrations of opposite sign within a 2 mm central zone, extending depth of focus by approximately 1.5 D, while its periphery remains aberration-neutral to preserve retinal image quality. The lens is made from hydrophobic acrylic with four-point haptic fixation and filters both UV and violet light [5].

Conceptually, Vario relies on a segmental refractive add, while LuxSmart manipulates spherical aberrations centrally. Both approaches are non-diffractive, thus avoiding the ring-related halos of traditional multifocals. The optical design also affects tolerance to surgical alignment. A modeling study by Oltrup et al. (2021) assessed spherical and aspheric IOLs under decentration and tilt, using contrast sensitivity function modeling to predict retinal image quality. They found aspheric IOLs generally perform better than spherical designs with larger pupils when centration is good, but are more sensitive to tilt and misalignment [13]. Because both Acunex Vario and

LuxSmart use aspheric or wavefront-modifying optics, precise centration and alignment are needed to achieve the expected contrast sensitivity benefits.

Contrast Sensitivity: Why It Matters

Contrast sensitivity is the ability to detect small differences in luminance across spatial frequencies. It governs performance in everyday settings such as night driving, reading faded print, or navigating dim environments. Cataracts markedly reduce CS, and while cataract removal improves it, different IOL designs affect postoperative CS differently.

Monofocal aspheric IOLs remain the benchmark, consistently outperforming EDOFs in CS. Multifocals, especially diffractive trifocals, typically reduce CS at mid- and high-spatial frequencies under mesopic conditions. The goal of EDOF lenses is to expand functional vision range, but with only minimal compromise in contrast sensitivity [6].

Evidence for Acunex Vario

Clinical data for Acunex Vario are encouraging. In a prospective 40-eye study, Rua Amaro et al. reported excellent uncorrected distance (-0.08 logMAR), intermediate (-0.03 logMAR), and near (0.16 logMAR) acuities three months postoperatively. Contrast sensitivity was comparable to monofocal controls across most frequencies. The defocus curve showed functional vision from +1.50 to -2.45 D, indicating a wide range without abrupt drops [5].

Wanten et al. compared Acunex Vario with AcrySof IQ Vivity in a randomized controlled trial [6]. Both groups performed equally well in visual acuity and CS under photopic and mesopic conditions. Vario showed a slightly wider defocus range, potentially translating into smoother intermediate performance. Patient satisfaction and dysphotopsia rates were high in both groups.

Our recent comparative trial using the RM-800 contrast sensitivity function device demonstrated that both Acunex Vario and LuxSmart improved CS relative to cataractous eyes. As expected, monofocal controls maintained the strongest CS performance, but differences between the two EDOF designs were minimal, with Acunex Vario showing a slight advantage at distance [7].

Evidence for LuxSmart

LuxSmart has been studied in smaller but growing cohorts.

Stodulka and Pracharova evaluated 60 eyes over six months and found good refractive predictability, stable outcomes, and high satisfaction [2]. Photopic CS was within normal ranges at most frequencies, with a slight dip at higher frequencies. Mesopic CS was lower but functionally adequate. Halos and glare were rare.

Campos et al. reported on LuxSmart with a mini-monovision approach, targeting emmetropia in the dominant eye and -0.50 D in the fellow eye [8]. This improved intermediate and functional near vision while maintaining good CS and overall satisfaction. Some patients still needed reading glasses for fine near work but most were spectacle-independent for daily distance and intermediate tasks.

In our comparative dataset, LuxSmart achieved similar outcomes to Acunex Vario. Subgroup analysis suggested that LuxSmart may perform slightly better for intermediate CS in bright-light conditions, especially in patients with smaller pupils, while Acunex Vario had a modest edge for distance vision [7].

EDOFs in the Bigger Picture

A Cochrane review comparing trifocals with EDOFs,

primarily Symphony, found distance visual acuity to be similar, with trifocals offering better near acuity, while EDOFs provided fewer photic phenomena and better contrast sensitivity overall [3].

Gundersen and Potvin (2020) compared toric trifocal and toric EDOF IOLs [12]. They reported no significant differences in distance and intermediate acuity, low-contrast acuity, or CS under photopic and mesopic conditions with glare. Only trifocals had better near acuity. Sudhir et al. (2019) compared the PanOptix trifocal with other trifocals and the Symphony EDOF lens [14]. PanOptix had an intermediate focal point at ~60 cm, closer to computer working distances than the ~80 cm of other trifocals. Contrast sensitivity was comparable across PanOptix, other trifocals, and Symphony. PanOptix provided better near acuity and higher rates of spectacle independence. However, patients more often reported halos and glare, usually mild and decreasing over time with neural adaptation.

Non-diffractive designs such as AcrySof IQ Vivity also demonstrate CS close to monofocals and better than trifocals under both photopic and mesopic conditions [9]. Wanten et al. confirmed Acunex Vario matched Vivity in CS but offered a slightly broader defocus curve [6]. However, patients more often reported halos and glare, usually mild and decreasing over time with neural adaptation.

| Feature | Monofocal IOLs | Acunex Vario (Teleon) | LuxSmart (B+L) | Trifocal IOLs |
|----------------------|--|---|---|--|
| Contrast Sensitivity | Gold standard; highest CS, especially in mesopic/glare | Near-monofocal CS; broad defocus; slight edge at distance | Preserves CS; slight advantage at intermediate (photopic) | Reduced vs monofocals/EDOFs; more affected in mesopic/glare |
| Distance Vision | Excellent | Excellent | Excellent | Excellent |
| Intermediate Vision | Limited | Very good; smooth defocus curve | Very good; small pupil/photopic advantage | Good; depends on focal design (~60–80 cm) |
| Patient Satisfaction | High for clarity; low for spectacle independence | High; manage near expectations | High; mini-monovision increases satisfaction | High if spectacle independence prioritized; photic issues possible |

Table 1. Key clinical comparisons of monofocal, Acunex Vario, LuxSmart, and trifocal intraocular lenses

Patient Satisfaction and Quality of Vision

Patient-reported outcomes align with clinical data, showing high satisfaction with both Acunex Vario and LuxSmart for distance and intermediate function. Reports of glare and halos are markedly lower than with diffractive multifocals [2,5–8].

Mini-monovision strategies with LuxSmart can

increase near independence but require careful patient selection. Acunex Vario’s smooth defocus profile may improve comfort for reading screens and dashboards. Some patients remain spectacle-dependent for fine print with both lenses, which should be explained clearly before surgery.

Methods

This review summarizes clinical evidence on contrast sensitivity with Acunex Vario (Teleon) and LuxSmart (Bausch + Lomb) EDOF intraocular lenses. We searched PubMed, Scopus, and Web of Science up to May 2025 using combinations of the terms: “Acunex Vario,” “LuxSmart,” “extended depth of focus intraocular lens,” “EDOF IOL,” “contrast sensitivity,” “defocus curve,” “visual acuity,” and “cataract surgery.” We also screened reference lists of relevant studies to capture additional publications.

We included peer-reviewed clinical studies, either prospective or retrospective, that evaluated Acunex Vario or LuxSmart alone or in comparison with monofocal, multifocal, or other EDOF IOLs. Eligible studies assessed contrast sensitivity under photopic or mesopic conditions and reported outcomes such as visual acuity, defocus curves, or patient satisfaction. Only English-language articles were considered. Preference was given to studies with adequate sample size and at least three months of follow-up.

We excluded case reports, conference abstracts, non-peer-reviewed articles, very small series, inconclusive reports, and studies with follow-up too short to be meaningful. If multiple publications reported the same cohort, the most complete dataset was used.

Limitations and Methodological Considerations

Most available studies involve small patient groups and short follow-up, so the long-term durability of results remains uncertain. Future research should determine whether the observed CS advantages persist in the long term, particularly once posterior capsule opacification or other age-related ocular changes occur. [3,9].

Another limitation is the lack of standardized testing. Different studies used different tools (Pelli-Robson, CSV-1000, RM-800) and varied lighting or glare conditions, making direct comparison difficult. Future research would benefit from uniform protocols that measure multiple spatial frequencies under both photopic and mesopic settings.

Patient factors such as age, ocular comorbidities and preoperative refraction also influence outcomes. Taking these factors into account is important to isolate the effect of the IOL itself.

Finally, most current studies are based on relatively few

patients and follow-up rarely extends beyond six months, and should be considered when interpreting the effect of the IOL itself.

Future Directions

Future research should focus on standardizing contrast sensitivity protocols, larger studies with longer follow-up, and broader comparative trials including designs such as Mini Well, Vivity, and IC-8.

Advances in biometry, aberrometry, and artificial intelligence will enable more personalized IOL selection. Research into neural adaptation will also help clarify how patients adjust to subtle CS changes over time [11].

Clinical Take-Home Messages

Monofocal IOLs continue to be the reference point for contrast sensitivity, especially in mesopic and glare conditions. Acunex Vario provides contrast sensitivity close to monofocals, with a broad defocus curve and slightly better distance performance. LuxSmart also maintains normal CS, performing somewhat better at intermediate distances under photopic conditions, particularly with mini-monovision. Trifocals give the greatest near independence, but at the expense of contrast sensitivity and with more photic phenomena. Patient satisfaction is high with both EDOFs, provided patients are counseled about the likely need for reading glasses for fine near tasks.

Conclusion

Contrast sensitivity critically affects real-world visual function. Non-diffractive EDOF IOLs such as Acunex Vario and LuxSmart preserve CS significantly better than diffractive multifocals while extending functional vision beyond monofocals. The differences are subtle: Acunex Vario offers a slight edge for distance vision, LuxSmart may excel at intermediate vision, and both perform close to monofocals overall.

These lenses are good options for patients who want sharp distance and intermediate vision with minimal halos and glare, and who accept the possibility of needing glasses for fine print. With more studies and continued lens design improvements, EDOFs may become a routine recommendation for many cataract patients in the future.

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