Clinical Ophthalmology

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ORIGINAL RESEARCH

A Retrospective Comparative Performance Analysis of Multifocal Eyecryl Actv IOL and the World's First Progressive Polyfocal Autofocus Pro IOL

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Purpose: This is the first study evaluating the visual outcomes of the novel Progressive Polyfocal Autofocus Pro intraocular lens (IOL) (Lifeline Medical Devices Pvt. Ltd. Aurangabad, India) and comparing them with Eyecryl Actv multifocal IOL (model DIYHS600ROH, Biotech Vision Care Pvt. Ltd. Ahmedabad, India) at the first and sixth weeks after implantation in Indian eyes.

Patients and Methods: A retrospective nonrandomized, comparative study was conducted based on hospital records of patients operated for cataract between January 2019 and January 2021 with bilateral implantation of one of the two presbyopia-correcting IOLs. Patients aged between 11 and 78 years, with preoperative astigmatism of 1 diopter or less and no other ocular disorders, were included. Visual acuity for distance, intermediate and near, refractive outcomes, contrast sensitivity, reading speed, depth of focus, patient satisfaction, and presence of optical phenomenon classically faced with conventional presbyopia-correcting IOLs were evaluated at 6 weeks postoperatively.

Results: Of 104 eligible patients, intermediate visual acuity scores, reading speed, contrast sensitivity, depth of focus, and patient satisfaction were better with the Autofocus Pro IOL (all $P<0.001$). Negative dysphotopsias were absent in the Autofocus Pro group, whereas they were seen in about one-third of patients in the Multifocal group ($P<0.001$). Halos and glare were also significantly lower in the Autofocus Pro group. There was no difference in the distance and near visual acuity.

Conclusion: This study highlights superior clinical outcomes and patient satisfaction associated with Autofocus Pro IOLs compared to Multifocal IOLs, indicating their potential as a preferred choice for cataract surgery.

Keywords: cataract, intraocular lens, negative dysphotopsia, patient-reported outcomes, visual acuity

Introduction

Cataract is the leading cause of reversible visual impairment and blindness worldwide.[1] Operating cataracts is fast becoming a refractive surgery with increasingly demanding patients asking for spectacle independence while performing day-to-day tasks.[2] Premium intraocular lenses (IOLs) are continually being developed to meet this demand for distance, intermediate, and near vision, enabling patients to achieve near-normal quality of life after cataract surgery. The commonly described presbyopia-correcting IOLs are available in various designs—diffractive, refractive, and diffractive-refractive. These IOLs have rings of multiple configurations and focal distances, allowing light from varying object distances to fall on the retina. These lenses may be bifocal, trifocal, extended-depth-of-focus (EDOF), or continuous range of vision (CRV) lenses, depending on the peak distribution of light for varying focal distances.[3] All these lenses have their advantages and disadvantages; however, the quest for an ideal intraocular lens without any visual side effects is still on.

Received: 11 February 2025
Accepted: 22 April 2025
Published: 28 April 2025

Recently, rotationally asymmetric, refractive, ringless multifocal IOLs have been introduced—for example, the ClearView 3 IOL (Lenstec, Inc., Christ Church, Barbados) has been USFDA-approved for presbyopia correction with cataract surgery.[4] The optics of these IOLs have a change of refractive power in a vertical progression akin to a presbyopia-correcting spectacle lens. These are usually designed with two segments with different refractive indexes (for distance and near vision respectively), with an aspheric transition area which prevents blurred vision due to interference and diffraction since it reflects the incident light from the optical axis. With many advances in design, these IOLs show better patient satisfaction, contrast sensitivity, and improved visual outcomes compared to other diffractive or refractive MFIOLs.[5] As demonstrated in recent studies, although the asymmetricity of the design makes it crucial to place the near segments at the intended location during surgery, these IOLs have the theoretical advantage of having no dysphotopsic side effects and no dependence on angles kappa and alpha.[5]

Considering the advantages of rotationally asymmetric refractive IOLs, a new IOL, the Spirant Autofocus Pro IOL (Lifeline Medical Devices Pvt. Ltd., Aurangabad, Bhavnagar, India) was created with the concept of gradient refractive index (GRIN). This novel design allows polyfocality with a progressive corridor in the lens design akin to a progressive spectacle lens. However, as this is a relatively new innovation, there is a paucity of studies in published literature comparing the IOLs of this design to popular presbyopia-correcting IOLs based on conventional principles of design.

The purpose of the present study was to evaluate and compare the visual outcomes and other parameters at the first and sixth weeks after implantation of two IOLs—the Eyecryl Actv diffractive-refractive multifocal IOL (model DIYHS600ROH, Biotech Vision Care Pvt. Ltd., Ahmedabad, India) and the progressive polyfocal Spirant Autofocus Pro IOL (Lifeline Medical Devices Pvt. Ltd., Aurangabad, Bhavnagar, India)—in Indian eyes.

Materials and Methods

This was a retrospective, non-randomized, comparative study conducted at a tertiary eye care center, based on hospital records of cataract patients between January 2019 and January 2021 who underwent bilateral implantation of one of the two presbyopia-correcting IOLs following cataract extraction. All these patients gave due consent to use their data for academic and research purposes under complete anonymity. The study conformed to the tenets of the Declaration of Helsinki and was approved by the institutional ethics committee of the All India Institute of Medical Sciences, Jodhpur, India.

Intraocular Lens Design

The Eyecryl Actv is an aspheric multifocal foldable IOL made with a naturally yellow hydrophilic material with a hydrophobic surface, delivered through a 1.8mm cartridge. Its conventional square edge design reduces posterior capsular opacification. Its diffractive-refractive design with concentric rings minimizes the occurrence of halos and glare and allows improved contrast sensitivity under mesopic conditions, and therefore patient comfort even in challenging lighting conditions, such as driving at night or reading. The IOL achieves an extended depth of focus, allowing improved visual outcomes for daily activities.

The Spirant Autofocus Pro is a foldable IOL made of Copolymer of Hydrophilic and Hydrophobic Monomers 60% Hydrophobic and 40% Hydrophilic material. It has an oval optic of 6 mm and a 1.5 mm plane collar around the optic (7.5 mm horizontal × 6.3mm vertical), and a haptic size of 5.5mm, amounting to an overall diameter of 13 mm horizontal dimension. The characteristic L-Loop haptic with zig-zag serrated outer edges has a vertical length of 6 mm. To reduce posterior capsular opacification, a double-ring square edge of Amon-Apple is present around the IOL. The optic has two dialing holes 300 μm in size, which are to be oriented superiorly and which also aid viscoelastic outflow into the anterior chamber. It has a distinctive GRIN (Gradient Refractive Index) technology—the refractive index comes to 1.46 on an average, but varies from 1.42 to 1.52 and provides progressive polyfocality. As there are no diffractive or refractive rings in this IOL, there is no loss of light energy. The top 60% of the optic is designed for distance vision, and the lower 25% for near vision, while the middle 15% is for intermediate distances. At all pupillary sizes, the ratio of the distribution of light remains the same; hence, it is pupil-independent, and angle alpha and angle kappa are of no significance. The large and horizontally oval optic design covers the whole visual field, preventing negative dysphotopsias, whereas in traditional 6 mm optic IOLs, there is an aphakic temporal visual field that causes a dark crescentic shadow on the nasal retina within the visual field.

Eligibility Criteria

The inclusion criteria comprised patients aged between 10 and 80 years with bilateral implantation of the same intraocular lens, preoperative astigmatism of 1 diopter or less, and no other ocular disorders. Patients with implantation of any IOL other than those under study, patients having corneal opacity, unhealthy retinas, or previous ocular surgery, or those who suffered any intraoperative or postoperative complications were excluded.

Study Procedure

Preoperative data collected included demographic details and data on any systemic illness, type of cataract, IOL power (calculated using the IOL Master 500 from Zeiss), and distance visual acuity in logMAR. All surgeries were performed by a single experienced surgeon (AKM) using standardized phacoemulsification techniques. Preoperative keratometry was performed using IOL Master 500 (Carl Zeiss Meditec, Germany) and the Total Keratometry values were taken into account for IOL power calculation using Barrett Universal II formula in all cases. Under topical or peribulbar anesthesia using the same phacoemulsification machine, a 2.6 mm limbal-based temporal incision and two 0.9 mm side ports at 6 and 12 o'clock positions were made. A manual central continuous curvilinear capsulorhexis of 5.25–5.75 mm was performed, followed by hydrodissection, phacoemulsification, bimanual cortex removal, capsular polishing, and in-the-bag IOL implantation. Post-operatively all patients were started on topical medication, including antibiotics (moxifloxacin hydrochloride 0.5%) 4 times a day for 2 weeks and corticosteroids (prednisolone acetate 1% starting 4 times a day) tapered weekly over the next 4 weeks.

Cases were followed up at the end of the first and sixth weeks postoperatively, described hereafter as visits 1 and 2, respectively. Variables assessed included corrected distance visual acuity (DVA-1 and 2), intermediate visual acuity (IVA-1 and 2), and near visual acuity (NVA-1 and 2). Residual refractive error (spherical equivalent), contrast sensitivity (using the Pelli-Robson chart), reading speed (words per minute), depth of focus (in diopters), patient satisfaction (scored on a Likert scale of 1 to 5), and the presence of negative dysphotopsia or photic phenomena (halos, glare) were also assessed at the last visit.

Statistical Analysis

Statistical analyses were performed using SPSS (IBM, Version 28.0). Descriptive statistics were presented as Mean ± SD or Median (IQR) for continuous variables and percentages for categorical variables. Shapiro–Wilk test was used to assess normality. Student's *t*-test/Mann–Whitney *U*-test and Chi-square/Fisher's exact test were used for comparisons between groups, while the Friedman test assessed longitudinal changes in logMAR vision over visits. A P-value < 0.05 was considered statistically significant.

Results

A total of 104 eligible patients were enrolled in the study, with 51 (49%) in the Autofocus Pro group and 53 (51%) in the Multifocal IOL group. The mean age of the participants was 51.92 ± 15.05 years, and 56 (53.8%) were male. Baseline demographic and clinical characteristics were comparable between the two groups (TableS 1 and 2).

Table 1 Demographic Factors

Parameters	Lens Type, n (%)		Overall, (n=104)	*P*-value
	Autofocus Pro, (n=51)	Multifocal, (n=53)		
Age in years				
Mean ± SD	52.35 ± 15.06	51.51 ± 15.18	51.92 ± 15.05	0.777[a]
Range	11–73	13–78	11–78	

(*Continued*)

https://doi.org/10.2147/OPTH.S521607

Table 1 (Continued).

Parameters	Lens Type, n (%)		Overall, (n=104)	*P*-value
	Autofocus Pro, (n=51)	Multifocal, (n=53)		
Gender				
Male	30 (58.8)	26 (49.1)	56 (53.8)	0.333[b]
Female	21 (41.2)	27 (50.9)	48 (46.2)	
Known Systemic Illness				
Asthma	1 (2)	4 (7.5)	5 (4.8)	0.477[b]
Dermatitis	1 (2)	-	1 (1)	
Diabetes	6 (11.8)	2 (3.8)	8 (7.7)	
Diabetes, Hypertension	3 (5.9)	4 (7.5)	7 (6.7)	
Cerebrovascular accident	1 (2)	-	1 (1)	
Hypertension	10 (19.6)	11 (20.8)	21 (20.2)	
Hypertension, Cardiac Illness	3 (5.9)	1 (1.9)	4 (3.8)	
Hypothyroidism	2 (3.9)	1 (1.9)	3 (2.9)	
Hyperthyroidism	2 (3.9)	1 (1.9)	3 (2.9)	
Nil	22 (43.1)	29 (54.7)	51 (49)	
Patients satisfaction				
2	-	3 (5.7)	3 (2.9)	**<0.001**[b]
3	-	16 (30.2)	16 (15.4)	
4	16 (31.4)	17 (32.1)	33 (31.7)	
5	35 (68.6)	17 (32.1)	52 (50)	

Notes: [a]Student's *t*-test/Mann Whitney *U*-test; [b]Chi-square/Fisher's exact test; Boldface indicates statistical significance.
Abbreviation: SD, Standard Deviation.

Table 2 Preoperative Clinical Parameters

Parameters	Lens Type, n (%)		Overall, (n=208)	*P*-value
	Autofocus Pro, (n=102)	Multifocal, (n=106)		
Preoperative Lens Status				
Anterior cortical Cataract	1 (1)	2 (1.9)	3 (1.4)	0.290[a]
Developmental Cataract	-	2 (1.9)	2 (1)	
NS-1+ASC+PSC	3 (2.9)	3 (2.8)	6 (2.9)	
NS-1+CC	-	1 (0.9)	1 (0.5)	
NS-1+PSC	4 (3.9)	3 (2.8)	7 (3.4)	
NS-2	8 (7.8)	6 (5.7)	14 (6.7)	
NS-2-3	2 (2)	4 (3.8)	6 (2.9)	
NS-2+CC	7 (6.9)	4 (3.8)	11 (5.3)	
NS-2+PPC	2 (2)	-	2 (1)	
NS-2+PPC+PSC	-	2 (1.9)	2 (1)	
NS-2+PSC	28 (27.5)	23 (21.7)	51 (24.5)	
NS-2+PSC+CC	-	3 (2.8)	3 (1.4)	
NS-3	1 (1)	2 (1.9)	3 (1.4)	
NS-3+CC	-	2 (1.9)	2 (1)	
NO-2	4 (3.9)	6 (5.7)	10 (4.8)	
NO-2+PSC	3 (2.9)	-	3 (1.4)	
NO-2+PSC+CC	-	4 (3.8)	4 (1.9)	
NO-3	7 (6.9)	5 (4.7)	12 (5.8)	
NS-4	3 (2.9)	4 (3.8)	7 (3.4)	
PPC	2 (2)	2 (1.9)	4 (1.9)	
Presenile Cataract	3 (2.9)	1 (0.9)	4 (1.9)	
PSC	24 (23.5)	27 (25.5)	51 (24.5)	

(*Continued*)

Table 2 (Continued).

Parameters	Lens Type, n (%)		Overall, (n=208)	*P*-value
	Autofocus Pro, (n=102)	Multifocal, (n=106)		
IOL Power				
Mean ± SD	21.39 ± 2.52	22.32 ± 1.99	21.86 ± 2.31	**0.004**[b]
Range	12–25	14.5–25.5	12–25.5	

Notes: [a]Chi-square/Fisher's exact test; Boldface indicates statistical significance; [b]Student's *t*-test/Mann Whitney *U*-test.
Abbreviations: CC, Cortical cataract; IOL, Intraocular lens; NO, Nuclear opalescence; NS, Nuclear sclerosis; PPC, Posterior polar cataract; PSC, Posterior subcapsular cataract, SD, Standard Deviation.

Both groups exhibited significant improvement in postoperative logMAR distance visual acuity (P<0.001; Table 3). From a median logMAR of 0.6 at baseline, a median logMAR of 0.0 (Snellen 6/6) was achieved in both groups by the second postoperative visit (P=0.160; Table 4 and Figure 1). The improvement in visual acuity seen over 6 weeks in

Table 3 Postoperative Clinical Parameters

Parameters	Lens Type, n (%)		Overall, (n=208)	*P*-Value
	Autofocus Pro, (n=102)	Multifocal, (n=106)		
Reading speed				
Mean ± SD	168.33 ± 25.21	101.41 ± 29.44	134.23 ± 43.29	**<0.001**[a]
Range	100–200	50–150	50–200	
Spherical equivalent				
Median (IQR)	0 (0–0.25)	0 (0–0.56)	0 (0–0.50)	**<0.001**[a]
Range	0–0.75	0–1	0–1	
Depth of Focus				
0.25 to −0.25	-	41 (38.7)	41 (19.7)	**<0.001**[b]
0.50 to −0.25	-	20 (18.9)	20 (9.6)	
0.50 to −0.50	-	17 (16)	17 (8.2)	
0.50 to −0.75	-	28 (26.4)	28 (13.5)	
1 to −2	34 (33.3)	-	34 (16.3)	
1 to −2.50	28 (27.5)	-	28 (13.5)	
1 to −3	23 (22.5)	-	23 (11.1)	
1 to −3.50	13 (12.7)	-	13 (6.3)	
1.50 to −1.50	3 (2.9)	-	3 (1.4)	
1.50 to −2	1 (1)	-	1 (0.5)	
Contrast Sensitivity				
Mean ± SD	1.69 ± 0.21	1.29 ± 0.12	1.49 ± 0.26	**<0.001**[a]
Range	1.4–2	1–1.4	1–2	
Negative Dysphotopsias				
No	102 (100)	72 (67.9)	174 (83.7)	**<0.001**[b]
Yes	-	34 (32.1)	34 (16.3)	
Halos and Glare				
No	102 (100)	70 (66)	172 (82.7)	**<0.001**[b]
Yes	-	36 (34)	36 (17.3)	

Notes: [a]Student's *t*-test/Mann Whitney *U*-test; [b]Chi-square/Fisher's exact test; Boldface indicates statistical significance.
Abbreviations: IQR, Interquartile range; SD, Standard deviation.

https://doi.org/10.2147/OPTH.S521607

Table 4 Distance Visual Acuity

Parameters	Lens Type, n (%)		Overall, (n=208)	*P*-value[a]
	Autofocus Pro, (n=102)	Multifocal, (n=106)		
Baseline				
logMAR Median (Snellen's VA)	0.60 (6/24)	0.60 (6/24)	0.60 (6/24)	0.160
IQR (logMAR)	0.30–0.80	0.50–0.80	0.40–0.80	
First visit				
logMAR Median (Snellen's VA)	0.10 (6/7.5)	0.10 (6/7.5)	0.10 (6/7.5)	0.095
IQR (logMAR)	0–0.10	0–0.20	0–0.10	
Second visit				
logMAR Median (Snellen's VA)	0 (6/6)	0 (6/6)	0 (6/6)	**<0.001**
IQR (logMAR)	0–0.05	0–0.10	0–0.10	
***P*-value**[b]	**<0.001**	**<0.001**	**<0.001**	

Notes: [a]Student's *t*-test/Mann Whitney *U*-test; [b]Friedman test; Boldface indicates statistical significance.
Abbreviations: IQR, Interquartile range; VA, Visual acuity.

both groups may be attributed to the resolution of transient corneal edema, anterior chamber reaction and stabilization of the IOL by collapse of the capsular bag around the IOL.

Intermediate visual acuity (IVA) scores, including IVA-1 and IVA-2, were significantly better in the Autofocus Pro group compared to the Multifocal group (P<0.001; Table 5 and Figure 2). However, no significant differences were observed in near visual acuity (NVA-1 and NVA-2) between the groups (P=0.088 and P=0.111, respectively; Table 6 and Figure 3).

Reading speed and contrast sensitivity were significantly superior in the Autofocus Pro group. The mean reading speed was 168.33±25.21 words per minute for Autofocus Pro IOL compared to 101.41±29.44 words per minute for Eyecryl Actv IOL (P<0.001). Contrast sensitivity was also higher in the Autofocus Pro group (1.69±0.21 vs 1.29±0.12, P<0.001, Table 3) as measured using Pelli-Robson charts.

Autofocus Pro IOL demonstrated better depth of focus, with 33.3% of patients achieving a range of −1 to −2 diopters (P<0.001, Figure 4). Patient satisfaction was significantly higher in the Autofocus Pro group, with most patients reporting a satisfaction score of 5 (P<0.001) using a Likert scale rating. Negative dysphotopsia was present in 32.1% of patients in

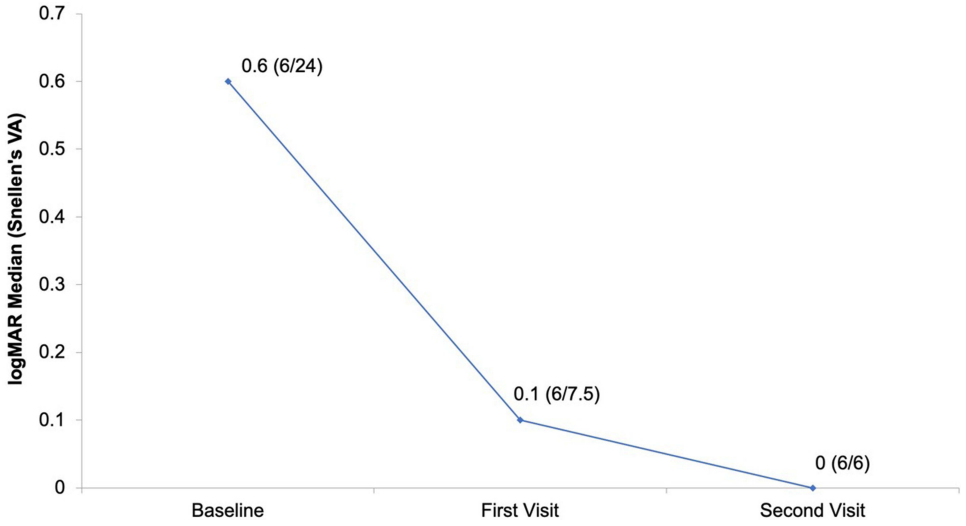

Figure 1 Line diagram for Distance Visual Acuity.

Table 5 Intermediate Visual Acuity (IVA)

Parameters	Lens Type, n (%)		Overall, (n=208)	*P*-value[a]
	Autofocus Pro, (n=102)	Multifocal, (n=106)		
IVA-1				
I-12	-	52 (49.1)	52 (25)	**<0.001**
I-18	-	32 (30.2)	32 (15.4)	
I-6	70 (68.6)	-	70 (33.7)	
I-8	32 (31.4)	22 (20.8)	54 (26)	
IVA-2				
I-12	-	67 (63.2)	67 (32.2)	**<0.001**
I-18	-	15 (14.2)	15 (7.2)	
I-6	92 (90.2)	-	92 (44.2)	
I-8	10 (9.8)	24 (22.6)	34 (16.3)	

Notes: [a]Chi square/Fisher's exact test; Boldface indicates statistical significance.
Abbreviations: IVA-1, Intermediate visual acuity at one month follow-up; IVA-2, Intermediate visual acuity at six months follow up.

the Multifocal group but was absent in the Autofocus Pro group (P<0.001). Similarly, complications such as halos and glare were significantly lower in the Autofocus Pro group compared to the Multifocal group (P<0.001, Table 3). Thus, this novel IOL design offered good refractive and visual outcomes over time, as observed by the trends in this study, with lower photic complications.

Discussion

Presbyopia is one of the most common refractive problems encountered in patients suffering from cataracts. Presbyopia as a visual problem is known to affect annual global productivity with losses amounting to approximately $25 million annually.[6,7] Cataract surgery, with the advances of intraocular implants, has the potential to treat refractive errors, including presbyopia, with a considerable success rate.[2]

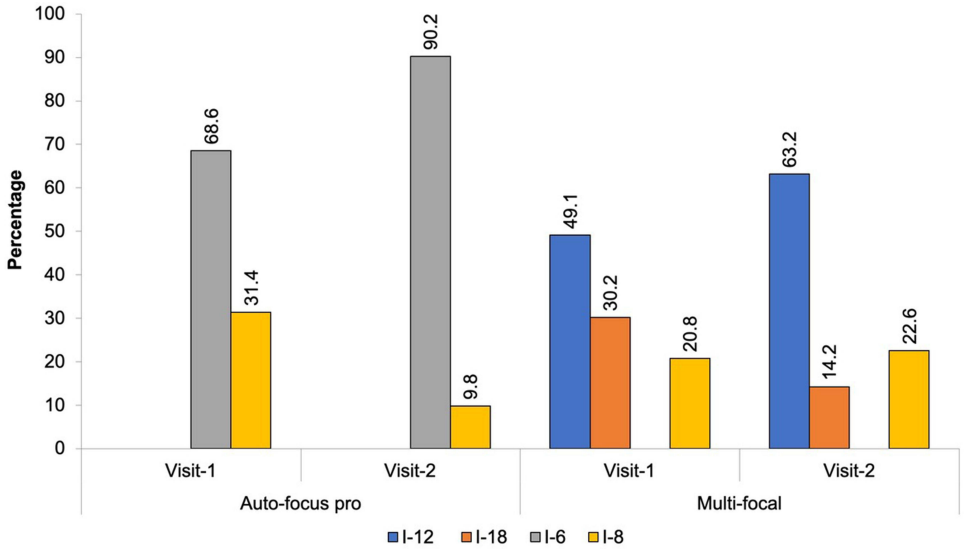

Figure 2 Bar graph showing Intermediate Visual Acuity (IVA) according to the lens type.

https://doi.org/10.2147/OPTH.S521607

Table 6 Near Visual Acuity (IVA)

Parameters	Lens Type, n (%)		Overall, (n=208)	*P*-value[a]
	Autofocus Pro, (n=102)	Multifocal, (n=106)		
NVA-1				
N12	-	4 (3.8)	4 (1.9)	0.088
N6	73 (71.6)	79 (74.5)	152 (73.1)	
N8	29 (28.4)	23 (21.7)	52 (25)	
NVA-2				
N12	-	4 (3.8)	4 (1.9)	0.111
N6	93 (91.2)	90 (84.9)	183 (88)	
N8	9 (8.8)	12 (11.3)	21 (10.1)	

Note: [a]Chi square/Fisher's exact test.
Abbreviations: NVA-1, Near visual acuity at one month follow-up; NVA-2, Near visual acuity at six months follow up.

This study of 104 subjects evaluated visual outcomes following implantation of the novel progressive gradient polyfocal IOL (Figure 5A) in comparison with an aspheric multifocal IOL (Figure 5B and Table 7). The present study showed significant improvements in near and distance VA in both groups with better intermediate visual acuity scores in the Autofocus Pro group. Since this is a novel study following the results of the implantation of Autofocus Pro IOL, it is difficult to compare the findings of this group with respect to other published studies. Findings of the comparator group, ie, the diffractive-refractive Eyecryl Actv DIYHS600ROH are similar to those observed by Agca et al. This study showed similar improvement in DVA and NVA, but results of IVA were better compared to our study, probably due to the different methodology adopted for measurement of IVA.[8]

With the changing needs of patients, there is greater importance in achieving superior intermediate visual acuity to enable the performance of intermediate distance tasks like computer work. Previous studies have shown that multifocal IOLs, which have two focal distances (distance and near), do not fare as well for intermediate distances.[9,10] To address this issue, low-add multifocal IOLs were introduced. In a multicenter study of one of these low-add multifocal IOLs (Tecnis ZKB00, Johnson and

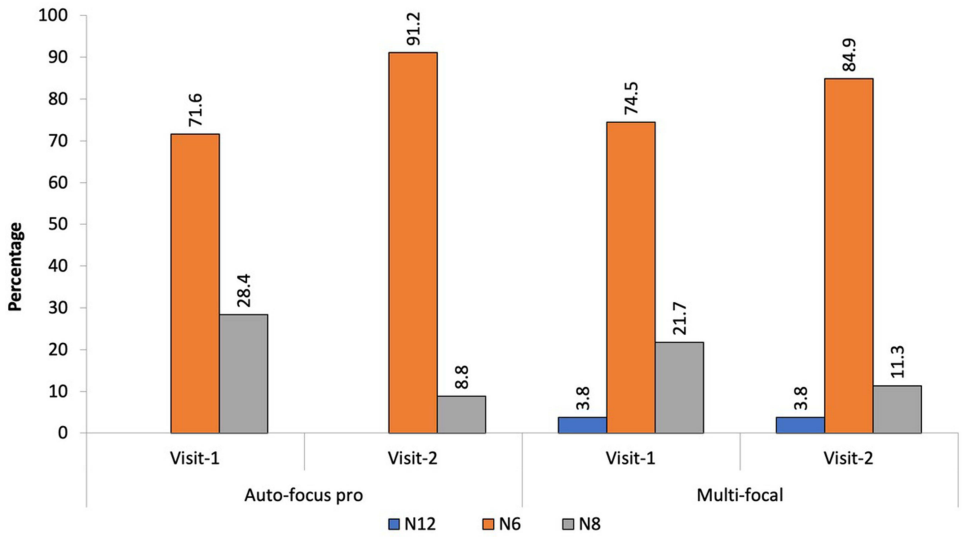

Figure 3 Bar graph showing Near Visual Acuity (NVA) according to the lens type.

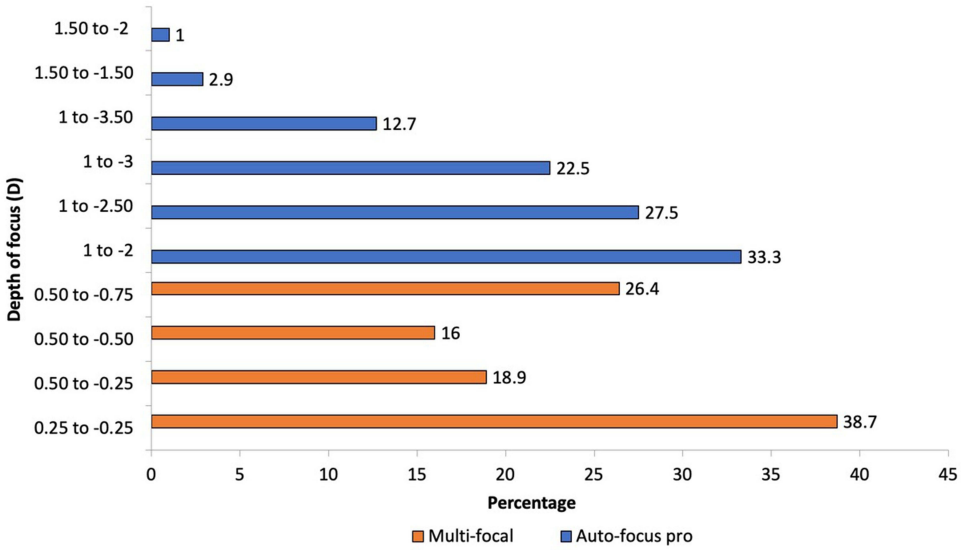

Figure 4 Bar graph showing Depth of Focus (DOF) according to the lens type.

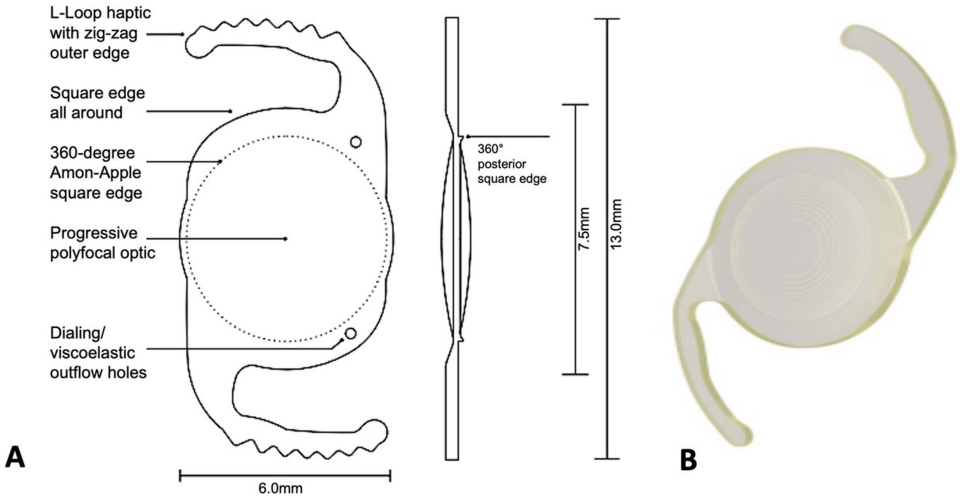

Figure 5 Intraocular lenses compared in the present study (**A**) Autofocus Pro (**B**) Eyecryl Actv.

Johnson Vision, USA), high patient satisfaction for IVA was reported with a near add of +2.75 D.[10,11] Despite this, dysphotopsic side effects, such as glare, halos, and loss of contrast sensitivity, continued to be reported.[12,13] To counter these side effects, refractive, rotationally asymmetric IOLs were introduced, which, instead of having concentric rings, have

Table 7 Comparison Between Eyecryl Actv and Spirant Autofocus Pro

	Eyecryl Actv DIYHS600ROH	**Spirant Autofocus Pro**
Material	Hydrophilic Acrylic containing Natural Chromophore	Copolymer of hydrophobic and hydrophilic acrylic monomers
Optic Type	Single Piece, Diffractive-Refractive, 360° Square Edge with Aspheric Optic	Single Piece, Oval, 360° Square Edge with Aspheric Optic

(*Continued*)

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Table 7 (Continued).

	Eyecryl Actv DIYHS600ROH	**Spirant Autofocus Pro**
Haptic type	Modified C-Loop	L loop with serrations
Technology	Diffractive-refractive ring design	Gradient Refractive Index (GRIN)
Pupil independence	No	Yes
Dialing holes	No	Two, 300µm in size, oriented superiorly
Near Addition	3.75D	Progressive polyfocality
Optic Shape	Circular	Oval
Optic Size	6.00 mm diameter	6.00 mm diameter
Overall Size	12.50 mm	13.00 mm
Angulation	5°	0°
Theoretical Anterior chamber depth	4.96	4.96
Refractive Index	1.46	1.46
Estimated A-Constant	118.0	Optical: 117.7
		Ultrasonic: 117.5
Manufacturer's recommendation for power selection	None specified	Select first minus
Diopter Range	3.0 D to 32.0 D (with 0.5 D steps)	+10.0 to + 30.0 D in 0.5 D (+5.0 to +9.0 and +31.0 to +40.0 in 1.0 D) increments
Implantation Site	Capsular Bag	Capsular Bag
Sterilization	Steam	Irradiation Steam

two sectors.[14] The IOL has segments—the larger superior segment provides distance vision, and a smaller surface-embedded inferior segment provides near vision with a smooth transition zone in between.[14]

Conceptually designed to have improved contrast sensitivity due to fewer transition zones with lesser energy loss, vertically progressive IOLs have been tested in various reports, which indicated that the implantation of these rotationally asymmetric IOLs provided high-quality uncorrected distance and near visual acuities (UDVA and UNVA) and showed high subjective satisfaction and lower spectacle dependence.[5,15] Various rotationally asymmetric multifocal intraocular lenses, like SBL-2, Clearview 3 (Lenstec, Inc., Christ Church, Barbados), Lentis Mplus LS-312 (Oculentis GmbH, Berlin, Germany), Mplus X (Topcon Europe Medical, Capelle aan den IJssel, Netherlands), etc., have been studied compared to multifocal IOLs and have demonstrated similar or superior visual outcomes.[5,16–19] These IOLs have better uncorrected IVA and NVA, with a much wider range of intermediate vision as reported by various studies. They also have a reduced incidence of dysphotopsic side effects and show high subjective satisfaction.[19,20]

In concurrence with previous studies on rotationally asymmetrical IOLs, our results suggest that with Autofocus Pro IOL as well, the near vision improves substantially from 1 week postoperatively (71.6% achieving N6 NVA) to 6 weeks (91.2% achieving N6 NVA), similar to the multifocal group (74.5%, 84.9%). However, 4 of our patients in the Multifocal group maintained near vision N12 at post-operative 6 weeks, whereas all patients in Autofocus pro group had a final NVA better than N12. A similar trend was seen in DVA scores with improvement over a 6-week interval. IVA was significantly better in the Autofocus Pro group compared to the Multifocal group at both postoperative visits.

Studies have also compared the outcomes of these segmented bifocal IOLs with each other. McNeely et al concluded that bilateral implantation of a 3.00D near add IOL (Lentis Mplus LS-312 MF30 vs SBL-3) with inferonasally-positioned near add segment resulted in similar outcomes.[21] A study by the same authors showed slightly superior outcomes for near vision and spectacle independence for the SBL-3 IOL.[21] Better scores of quality of vision were reported with the placement of a low near add IOL in the dominant eye (Lentis Mplus LS-312 MF20) with a superotemporal position of the near segment and an IOL with an inferonasally placed higher addition segment (SBL-3) in the non-dominant eye.[22] Good patient satisfaction scores with total spectacle independence of 92.0% have been described by a few for the SBL-2 IOL with a +2.00D near add.[23] A newer segmental refractive extended depth of focus IOL has also been evaluated to provide spectacle independence for distance and intermediate distances with functional near vision outcomes.[24]

Our study shows that Autofocus Pro has better DVA, NVA, and IVA 2 scores at final postoperative visits, with logMAR 0.0 to 0.1, N6, and I-6 being attained together by more than 90% of the patients implanted with this IOL. This is comparable to or superior to the values reported by studies on other rotationally asymmetric segmented IOLs, with higher subjective patient satisfaction scores and better contrast sensitivity.[5,25] Rosen et al, in a meta-analysis of multifocal IOLs, reported overall patient satisfaction ratings ranging from 62% to 100%, with dissatisfaction arising due to blurring, residual refractive error, posterior capsular opacification, large pupil size, and dry eye.[26] Patient satisfaction scores in the range of 93.5±6.12 (out of 100) have been described in a multicentric study of the apodized diffractive, multifocal AcrySof IQ ReSTOR SN6AD1 IOL having a +3.00 addition.[27]

Our study shows a patient satisfaction score of 100% with Autofocus Pro, qualitatively equivalent to a theoretically ideal scenario. This is also in concurrence with the findings of Hui et al, who reported that although trifocal IOLs perform better at intermediate distance and similarly at near vision when compared to rotationally asymmetric refractive IOLs (Lentis Mplus MF15 IOL with the +1.5 D power addition), the patient satisfaction scores are noted to be similar in the two groups.[28] In their study, the rotationally asymmetric refractive IOL group demonstrated better photic contrast sensitivity for higher spatial frequencies due to the seamless transition.[28] The authors also noted that a post-operative pseudomyopic error is observed with autorefractometry in eyes implanted with the segmented addition IOLs due to their geometrical asymmetry.[28–30]

Apparently, the Autofocus Pro IOL scores over other intraocular lenses because of its superior scientific design. The larger optic size with an oval shape provides pupil independence and prevents negative dysphotopsia. The SBL IOLs also have the near add covering a larger surface closer to the center of the IOL. The novel haptic design eliminates any significant tilt or decentration. Advantages of the L-loop haptic with zigzag serrations have also been studied by Borkenstein et al.[31] Their study showed a mean optic tilt of 2.85 ± 1.36° and a mean decentration of 0.27 ± 0.16 mm studied by Scheimpflug photography. Premium IOLs are affected maximally by tilt and decentration, which induce higher-order aberrations and affect optical quality as assessed using multiple regression analysis.[32] IOL decentrations of >0.5 mm cause significant visual degradation.[33] The novel ringless design of progressive polyfocality using Gradient Refractive Index (GRIN) technology helps in avoiding disruptive side effects like halos, glare, and starbursts arising out of decentration and tilt. These factors are also of great relevance, especially in selecting the correct intraocular implants in select patient populations. For example, Morya et al have emphasized that in diabetic patients, this vertically progressive IOL design may have distinct advantages.[34]

On studying the depth of focus, Autofocus Pro shows a better and more versatile defocus curve. This is similar to results seen with other rotationally asymmetric IOLs like SBL-3, etc.[19] The larger depth of focus compared to multifocal IOLs is hypothesized to be due to the introduction of some higher-order aberrations and due to the smooth transition zone between the segments of the IOL. These have the added advantage of providing better uncorrected NVA and IVA simultaneously.[18]

Reading speeds were better in the Autofocus Pro group at 168.33±25.21 vs 101.41±29.44 words per minute in the multifocal group. Similar reading speeds for multifocal IOLs were found by Hütz et al, with a maximum of 110 to 135 words per minute by Tecnis IOLs.[9] In future studies, reading speeds at various distances can be compared to enhance the validity of the results.

The present research is not without limitations. It is a preliminary retrospective study with a small sample size and short follow-up period. In the future, a larger population studied over 6 months to 1 year to evaluate long-term visual

outcomes, patient satisfaction scores using a questionnaire, contrast sensitivity at differing spatial frequencies, and study of corneal aberrations would enhance the power of the study and will support the promising clinical results presented here. Also, a comparison with another rotationally asymmetric multifocal intraocular lens may provide greater validity to our results. Further scope of studies involves the comparison of the use of Autofocus Pro in the dominant eye with a different presbyopia-correcting IOL in the non-dominant eye and the study of such combinations in patients with varying visual demands.

Conclusion

We have described clinical results with this new IOL whose optical design promises to eliminate the transitions between traditional focal distances compared to commercially available multifocal lenses. The results presented here are favorable, with virtually all patients achieving acceptable or even excellent uncorrected visual acuity at the different distances tested. The majority of patients did not experience optical phenomena and had a high rate of IOL acceptance. This study highlights the superior clinical outcomes and patient satisfaction associated with Autofocus Pro IOLs compared to Multifocal IOLs, indicating their potential as a preferred choice for cataract surgery.

Acknowledgments

Dr. Jagadeep M Kakadia, Dr. Satish D Shet, Dr. Vikrant Bhale, Dr. Bharat Gurnani, Dr. Kirandeep Kaur, Dr. Ranjeet Kumar Sinha.

Disclosure

Dr. RC Shah has a patent pending for the design of the Autofocus Pro intraocular lens (Indian Patent Application No – 202221028951). The rest of the authors report no conflicts of interest in this work.

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