ORIGINAL ARTICLE

Tailoring Extended Depth-of-Focus Intraocular Lens Design with Pupil Diameter and Spherical Aberration Profile

Refinando Lentes Intraoculares de Foco Estendido com Diâmetro Pupilar e Perfil de Aberração Esférica

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ABSTRACT

INTRODUCTION: Several intraocular lens (IOL) designs have been designed for the correction of presbyopia. The purpose of this study is to evaluate the visual performance of two IOL models and their variation according to spherical aberration (SA) and pupil diameter (PD).

METHODS: Prospective analysis of all patients implanted with AcrySof Vivity (“VIVITY”) or Precizon Presbyopic NVA (“PRESBY”) at the Refractive Surgery Unit of a tertiary hospital between January 2021 and December 2023. Patients with incomplete follow-up, amblyopia, and posterior capsule opacification were excluded. Defocus curve testing was performed at 0.5 diopters (D) intervals from +1.0 D to -3.0 D at the same examination room. PD, chord μ, and corneal wavefront profile was registered using a Scheimpflug system (Pentacam, Oculus).

RESULTS: We included 99 eyes of 54 patients - 50 eyes from the VIVITY group and 49 eyes from the PRESBY group. Baseline evaluation showed no significant differences. The VIVITY group showed better intermediate vision (logMAR 0.07 ± 0.06 *vs* 0.21 ± 0.25, $p<0.001$, respectively). The PRESBY group showed better near vision (logMAR 0.46 ± 0.11 *vs* 0.59 ± 0.16, $p<0.001$, respectively). Chord μ was not correlated with optical performance in either group. Near vision was positively correlated with PD (r=0.470, $p<0.001$ for 33 cm; r=0.350, $p=0.015$ for 40 cm; r=0.318, $p=0.028$ for 50 cm) and with SA (r=0.334, $p=0.02$ for 33 cm; r=0.374, $p=0.009$ for 40 cm; r=0.271, $p=0.062$ for 50 cm) only in the VIVITY group. Regarding PRESBY group, near vision was not significantly correlated with PD (r=-0.224, $p=0.143$ for 33 cm; r=-0.083, $p=0.593$ for 40 cm; r=-0.146, $p=0.343$ for 50 cm) and statistically independent of SA (r=-0.016, $p=0.912$ for 33 cm; r=-0.221, $p=0.131$ for 40 cm; r=-0.081, $p=0.584$ for 50 cm).

CONCLUSION: Each IOL performance in intermediate vision is different according to PD and SA: with VIVITY, it is better with smaller PD and less positive SA. With PRESBY, it is pupil-independent and clinically favored by more positive SA. Thus, preoperative evaluation of SA and PD near vision may influence the choice of refractive IOL for each patient.

KEYWORDS: Lens Implantation, Intraocular; Lenses, Intraocular; Presbyopia; Visual Acuity.

RESUMO

INTRODUÇÃO: Vários modelos de lente intraocular têm sido desenvolvidos para correção da presbiopia. O objetivo deste trabalho é avaliar a *performance* visual de dois modelos e sua variação de acordo com a aberração esférica (AS) e diâmetro pupilar (DP).

MÉTODOS: Análise prospetiva de doentes implantados com AcrySof Vivity ("VIVITY") ou Precizon Presbyopic NVA ("PRESBY") na Unidade de Cirurgia Refrativa de um hospital terciário entre Janeiro 2021 e Dezembro 2023. Pacientes com seguimento incompleto, e opacificação de cápsula posterior foram excluídos. A avaliação com curvas de desfocagem foi realizada em intervalos de 0,5 dioptrias (D) entre +1,0 D e -3,0 D. O DP, *chord μ*, e perfil de análise de frente-de-onda corneana foi registado usando uma câmara de Scheimpflug.

RESULTADOS: Foram incluídos 99 olhos de 54 pacientes (VIVITY: 50 olhos; PRESBY: 49 olhos). A avaliação *baseline* não revelou diferenças significativas. O grupo VIVITY demonstrou melhor visão intermédia (logMAR 0,07 ± 0,06 *vs* 0,21 ± 0,25, p<0,001, respetivamente). O grupo PRESBY revelou melhor visão de perto (logMAR 0,46 ± 0,11 *vs* 0,59 ± 0,16, p<0,001, respetivamente). O *chord μ* não se correlacionou com a performance ótica em qualquer grupo. A visão de perto demonstrou correlação positiva com o DP (r=0,470, p<0,001 a 33 cm; r=0,35, p=0,015 a 40 cm; r=0,318, p=0,028 a 50 cm) e com AS (r=0,334, p=0,02 a 33 cm; r=0,374, p=0,009 a 40 cm; r=0,271, p=0,062 a 50 cm) no grupo VIVITY. No grupo PRESBY, a visão de perto demonstra correlação negativa com DP (r=-0,224, p=0,143 a 33 cm; r=-0,083, p=0,593 a 40 cm; r=-0,146, p=0,343 a 50 cm) e estatisticamente independente de AS (r=-0,016, p=0,912 a 33 cm; r=-0,221, p=0,131 a 40 cm; r=-0,081, p=0,584 a 50 cm).

CONCLUSÃO: A *performance* de cada LIO na visão intermédia difere de acordo com DP e AS: no grupo VIVITY, a visão de perto é melhor com DP reduzidos e AS menos positiva. No grupo PRESBY, é independente do DP e favorecida por AS mais positiva. Assim, a avaliação pré-operatória da AS e DP poderá influenciar a escolha de LIO refrativa para cada paciente.

PALAVRAS-CHAVE: Acuidade Visual; Implantação de Lentes Intraoculares; Lentes Intraoculares; Presbiopia.

INTRODUCTION

A long journey has passed since the implantation of the first intraocular lens (IOL) by Sir Harold Ridley in 1949.[1] Cataract and refractive surgery has been driven by technology and is nowadays saluted by more than a hundred IOLs in the market.[2] The increase in life expectancy and lifestyle changes has stimulated patient demands and expectations for spectacle-independent near and intermediate vision.[3] This has stimulated the development of several presbyopia correcting IOLs.

Given the heterogeneity regarding IOL nomenclature, an evidence-based functional classification was developed to overcome these difficulties.[4,5]

The basic principle underlying EDOF IOLs is to create a single, elongated focal point to enhance depth of focus, thereby improving intermediate vision without compromising distance vision. Compared to traditional MF IOLs, this technology avoids out-of-focus images corresponding to secondary foci, thereby minimizing photic phenomena and contrast degradation.[2,6–10]

Depth-of-focus (DoF) can be titrated either by SA or pupil diameter (PD). Corneal SA occurs due to a higher angle of incidence and increased convergence of peripheral versus paraxial incident rays. Its neutralization can improve distance visual performance, albeit at the cost of decreased DoF.[6,11–14] On the other hand, smaller pupils improve depth-of-focus at the expense of reduced contrast sensitivity given the increased diffraction.

Thus, the purpose of this study was to compare the optical performance of two different IOLs and the role of SA and pupil diameter in its modulation.

METHODS

STUDY DESIGN

We conducted a prospective analysis of patients previously submitted to uneventful phacoemulsification and in-the-bag IOL implantation of either Acrysoft IQ Vivity DFT015 (Alcon Laboratories, Inc., USA) or Precizon Presbyopic NVA (Ophtec, The Netherlands) via a 2.4 mm clear corneal incision. This study was set at the Refractive Surgery Unit of the Ophthalmology Department of Santo António Local Health Unit, a tertiary hospital, between January 2021 and December 2023.

The Acrysoft IQ Vivity DFT015 (Alcon Laboratories, Inc., USA) is a non-diffractive EDOF IOL with Alcon's X-WAVE technology – it combines a central plateau and a

change in radial curvature to stretch and produce a wavefront shift, thereby extending depth-of-focus. Its design (aspherical front surface and spheric rear surface) corrects -0.20 μm of the cornea's spherical aberration (SA) and improves the optical quality of vision.[6,15–17]

The Precizon Presbyopic NVA (Ophtec, The Netherlands) is a hybrid acrylic IOL designed to correct presbyopia and compensate for -0.11 μm of SA. It combines refractive optics to enhance depth of focus across a continuous transitional focus which, in fact, behaves as a sectorial bifocal refractive IOL.[17,18]

The study was approved by our institutional review board and ethics committee - Departamento de Ensino Formação e Investigação, Unidade Local de Saúde Santo António, (2021.037(029-DEFI/030-CE) and conducted accordingly to the principles of the Declaration of Helsinki for the protection of human subjects in medical research.

PARTICIPANTS AND PROTOCOL

Only patients with uneventful surgery and implantation of either AcrySof Vivity (Alcon Laboratories, Inc., USA) or Precizon Presbyopic NVA (Ophtec, The Netherlands) were included.

Patients submitted to previous intraocular surgery (including previous laser vision correction), intraoperative complications, other ocular pathology (namely, neovascular age-related macular degeneration, macular edema of any etiology, glaucoma, uveitis, ocular trauma, and amblyopia), and incomplete follow-up were excluded.

Preoperatively, all patients underwent corneal tomography using the same Scheimpflug system (Pentacam, Oculus). Pupil diameter, chord μ, asphericity coefficient (Q), and total corneal wavefront in the 4 mm zone around the corneal vertex (SA; Root Mean Square [RMS] for lower (LOA) and higher (HOA) order aberrations; Coma at 0º and 90º). The examination was performed under the same controlled mesopic conditions for all patients (windowless examination room with the same illumination).

Subsequently, subjects underwent surgery with standard phacoemulsification techniques using the Centurion® system (Alcon Laboratories, Inc., USA) through a 2.4 mm clear corneal incision and in-bag intraocular lens (IOL) implantation. The IOL power was chosen by the surgeon without limitation on the formulas used and after discussion of the refractive target with the patient.

Monocular corrected distance (6 m) visual acuity (CDVA) and distance-corrected near (40 cm) visual acuity (DCNVA) were assessed between 6-12 months of follow-up. Standardized Snellen charts were used for visual acuity measurement at the same examination room and at the same time of the day (2-6 p.m.). Visual acuity at 40 cm was measured using standardized Jaeger notation. Data was subsequently converted to the logarithm of the Minimum Angle of Resolution (logMAR) in an Excel spreadsheet.

Manifest refraction was performed by the same investigator (BBR) using 100% contrast Snellen charts under photopic light conditions (167 candelas/m^2).

Monocular distance-corrected defocus curve testing was performed from -3.0 D to +1.0 D in 0.5 diopters (D) increments under photopic lighting conditions. Measurement was performed using varying Snellen charts to minimize the learning effect. First, negative lenses were added in 0.5 D incremental steps. Then, positive lenses were used to test visual acuity at the corresponding defocus level.

OUTCOMES

Eyes were divided according to the type of implanted IOL. Defocus curves were compared for near (-2.0 D, -2.5 D, -3.0 D), intermediate (-0.5 D, -1.0 D, -1.5 D) and far (0 D) vision. Baseline comparison was made for pupil diameter, chord μ, asphericity, and corneal wavefront profile. Correlations with far, intermediate and near vision were performed. Subgroup analysis was performed according to the type of IOL, pupil diameter (inferior and superior to 2.6 mm; 2.8 mm; 3.0 mm; and 3.2 mm, respectively) and spherical aberration (inferior and superior to 0.20 μm; 0.28 μm; 0.30 μm; and 0.40 μm, respectively).

STATISTICAL ANALYSIS

Statistical analysis was performed using the SPSS software (SPSS statistics, version 26.0.0 for Mac OS, IBM, Somers, NY). All measurements are expressed as mean ± standard deviation. The Kolmogorov-Smirnov test was used to assess normality. Comparison between independent continuous variables was evaluated using the Mann-Whitney U test and the T-Student test. Fisher's exact test was used for nominal scaled data. Pearson's bivariate correlation test was applied to study correlations. *P* values less than 0.05 were considered statistically significant.

RESULTS

One hundred and forty-five eyes of 84 patients were included. Thirty-six eyes were excluded (26 in VIVITY and 20 in PRESBY groups) due to posterior capsule opacification (7), amblyopia (4), or incomplete follow-up (25). Ten eyes were excluded due to missing data. Final sample rendered 99 eyes of 54 patients – 50 eyes (of 29 patients) in VIVITY and 49 eyes (of 25 patients) in PRESBY groups. Most patients were female (n=36 [66.7%]) with a mean age of 64.6 ± 12.5 years and no significant difference between groups. Mean postoperative SE was 0.01 ± 0.07 D for VIVITY and -0.01 ± 0.16 D for PRESBY, respectively, p=0.443. Baseline evaluation rendered no significant differences regarding PD, chord μ, and corneal wavefront profile. Full data is shown in Table 1. Eight eyes (2 from VIVITY and 6 from PRESBY group, respectively) had been previously submitted to posterior capsulotomy.

Defocus curve for both IOLs is shown in Fig. 1. The VIVITY group showed better far (logMAR 0.01 ± 0.06 *vs* 0.04 ± 0.06, p=0.011, respectively) and intermediate vision (logMAR 0.21 ± 0.09 *vs* 0.25 ± 0.07, p=0.016, respectively for 67 cm; logMAR 0.14 ± 0.10 *vs* 0.21 ± 0.08, p<0.001, respectively for 100 cm). The PRESBY group showed better near

Table 1. **Pupil diameter, angle kappa and corneal wavefront profile for both IOLs.**

	Vivity	Presby	*p*-value
Pupil diameter	2.98 ± 0.43 [2.11, 4.29]	3.04 ± 0.75 [1.74, 5.53]	0.674[1]
Chord μ	0.28 ± 0.14 [0.06, 0.76]	0.26 ± 0.14 [0.04, 0.62]	0.460[1]
Asphericity	-0.16 ± 0.26 [-0.63, 0.20]	-0.21 ± 0.16 [-0.63, 0.09]	0.148[1]
Corneal wavefront profile			
Spherical aberration	0.29 ± 0.10 [0.10, 0.48]	0.28 ± 0.09 [0.03, 0.48]	0.683[1]
RMS (total)	1.98 ± 0.86 [0.64, 3.47]	2.03 ± 0.86 [0.51, 5.20]	0.784[1]
RMS-HOA	0.55 ± 0.24 [0.34, 1.48]	0.48 ± 0.16 [0.21, 0.96]	0.063[1]
RMS-LOA	1.88 ± 0.90 [0.17, 3.44]	1.91 ± 1.00 [0.44, 5.18]	0.869[1]
Coma 0º	0.04 ± 0.25 [-0.43, 0.64]	0.03 ± 0.17 [-0.29, 0.59]	0.811[1]
Coma 90º	0.06 ± 0.16 [-0.41, 0.44]	0.04 ± 0.22 [-0.29, 0.80]	0.594[1]

RMS, root mean square; HOA, higher order aberrations; LOA, lower order aberrations; All values are displayed as mean ± standard-deviation [range];
[1] Independent-samples T-test;

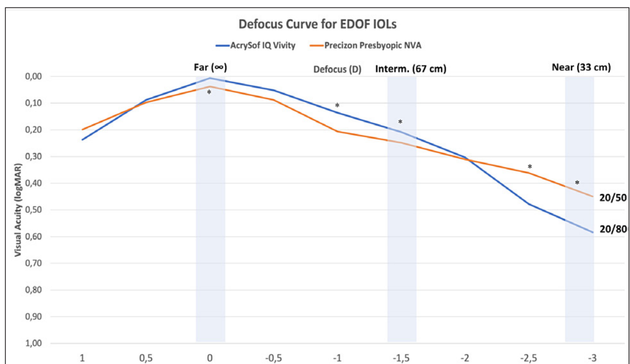

Figure 1. Defocus curve for extended depth-of-focus (EDOF) IOLs.
* corresponds to $p<0.05$ comparing both groups at each diopter (D).

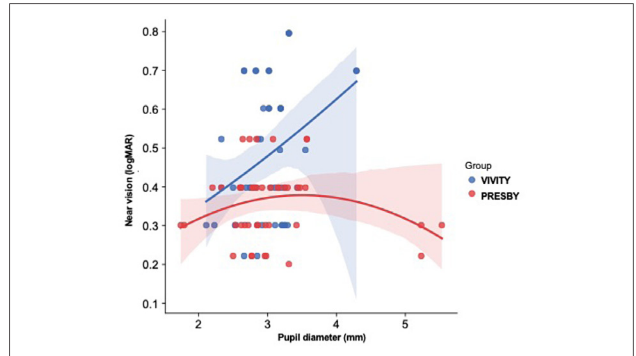

Figure 2. Scatter plot showing the correlation between pupil diameter and near vision.

vision (logMAR 0.45 ± 0.11 *vs* 0.58 ± 0.16, $p<0.001$, respectively for 33 cm; logMAR 0.36 ± 0.10 *vs* 0.48 ± 0.17, $p<0.001$, respectively for 40 cm). Full data is shown in Table 2.

Chord μ was not significantly correlated with optical performance in either group (VIVITY: r=0.100, p=0.495 for near and r=0.259, p=0.072 for intermediate, respectively; PRESBY: r=0.005, p=0.971 for near and r=-0.003, p=0.985 for intermediate, respectively).

Table 3 shows eye stratification according to PD and SA. Fig. 2 shows the correlation between pupil diameter and near vision. Near vision was positively correlated with pupil diameter (r=0.470, $p<0.001$ for 33 cm; r=0.35, p=0.015 for 40 cm; r=0.318, p=0.028 for 50 cm) only in the VIVITY group. Regarding PRESBY, near vision showed a reverse correlation with pupil diameter, albeit without statistical significance (r=-0.224, p=0.143 for 33 cm; r=-0.083, p=0.593 for 40 cm; r=-0.146, p=0.343 for 50 cm).

Fig. 3 shows the correlation between pupil diameter and intermediate vision. Intermediate vision was positively correlated with pupil diameter (r=0.296, p=0.041 for 67 cm; r=0.072, p=0.626 for 1 m) only in the VIVITY group. There was no significant correlation between intermediate vision and pupil diameter in the PRESBY group (r=0.036, p=0.815 for 67 cm; r=0.052, p=0.736 for 1 m).

Table 2. **Best-corrected visual acuity for both IOLs.**

	Vivity	Presby	*p*-value
BCVA (logMAR)			
Far			
0 D	0.01 ± 0.06	0.04 ± 0.06	**0.011**
Intermediate			
-0.5 D	0.05 ± 0.06	0.09 ± 0.17	0.161
-1.0 D	0.14 ± 0.10	0.21 ± 0.08	**<0.001**
-1.5 D	0.21 ± 0.09	0.25 ± 0.07	**0.016**
Near			
-2.0 D	0.30 ± 0.12	0.31 ± 0.09	0.736
-2.5 D	0.48 ± 0.17	0.36 ± 0.10	**<0.001**
-3.0 D	0.58 ± 0.16	0.45 ± 0.11	**<0.001**

BCVA, best-corrected visual acuity; logMAR, logarithm of the minimum angle of resolution; All values are displayed as mean ± standard-deviation.

Table 3. Eye stratification according to pupil diameter and spherical aberration.

	Vivity, n(%)	Presby, n(%)	*p*-value
Pupil diameter			**0.139**[2]
<3 mm	23 (47.9)	27 (61.4)	
>3 mm	25 (52.1)	17 (38.6)	
Spherical aberration			**0.342**[2]
<0.28 µm	23 (47.9)	25 (52.1)	
>0.28 µm	25 (54.2)	22 (45.8)	

[2] Fisher's exact test.

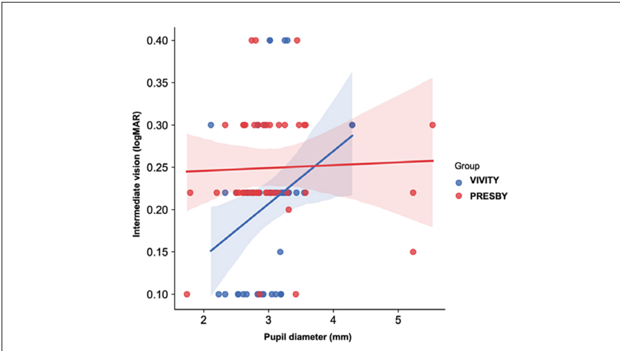

Figure 3. Scatter plot showing the correlation between pupil diameter and intermediate vision.

Fig. 4 shows the defocus curve for each type of IOL and according to pupil diameter (inferior and superior to 3 mm, respectively). Near vision was superior for pupil diameters <3 mm (*p*=0.009 for 33 cm; *p*=0.088 for 40 cm; *p*=0.052 for 50 cm) in VIVITY group. There was no significant near vision improvement with pupil diameters <3 mm (*p*=0.991 for 33 cm; *p*=0.330 for 40 cm; *p*=0.826 for 50 cm) in PRESBY group.

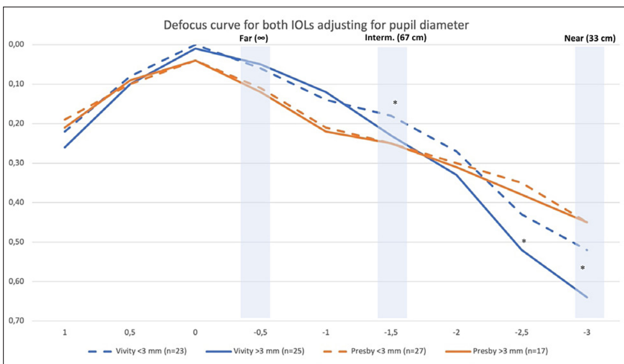

Figure 4. Defocus curve stratified by type of IOL and pupil diameter.

* corresponds to *p*<0.05 at each diopter (D) between same group at different pupil diameters.

Fig. 5 shows the correlation between SA and near vision. Near vision was positively correlated with SA (r=0.334, *p*=0.02 for 33 cm; r=0.374, *p*=0.009 for 40 cm; r=0.271, *p*=0.062 for 50 cm) in the VIVITY group. In the PRESBY group, there was a nonsignificant correlation between near vision and SA (r=-0.016, *p*=0.912 for 33 cm; r=-0.221, *p*=0.131 for 40 cm; r=-0.081, *p*=0.584 for 50 cm).

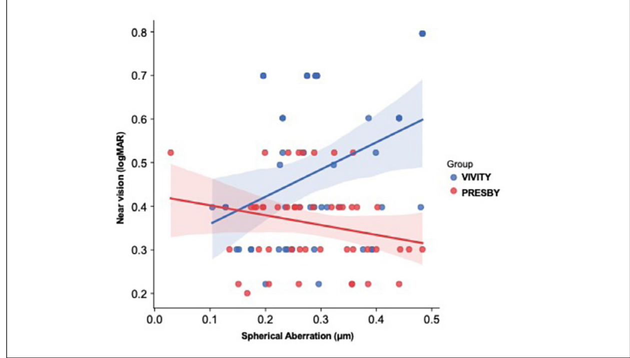

Figure 5. Scatter plot showing the correlation between spherical aberration and near vision.

Fig. 6 shows the correlation between SA and intermediate vision. Intermediate vision was negatively correlated with SA (r=-0.298, *p*=0.004 for 67 cm; r=-0.231, *p*=0.115 for 1 m) only in the PRESBY group. There was no significant correlation between intermediate vision and SA in the VIVITY group (r=0.047, *p*=0.750 for 67 cm; r=-0.149, *p*=0.313 for 1 m).

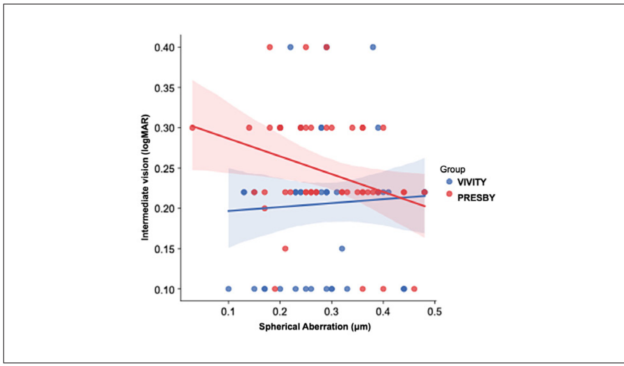

Figure 6. Scatter plot showing the correlation between spherical aberration and intermediate vision.

Fig. 7 shows the defocus curve for each type of IOL and according to spherical aberration (inferior and superior to 0.28 µm, respectively). Near vision was superior for SA <0.28 µm (*p*=0.021 for 33 cm; *p*=0.080 for 40 cm; *p*=0.032 for 50 cm) in the VIVITY group. There was no significant near

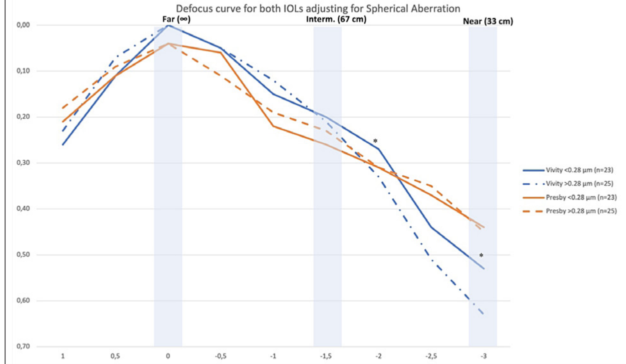

Figure 7. Defocus curve stratified by type of IOL and spherical aberration.

*corresponds to *p*<0.05 at each diopter (D) between the same group at different spherical aberration.

vision improvement with SA <0.28 μm (p=0.842 for 33 cm; p=0.401 for 40 cm; p=0.809 for 50 cm) in the PRESBY group.

Fig. 8 demonstrates a flowchart for the customized choice of EDOF IOL according with pupil diameter and corneal spherical aberration, as explained in the discussion section.

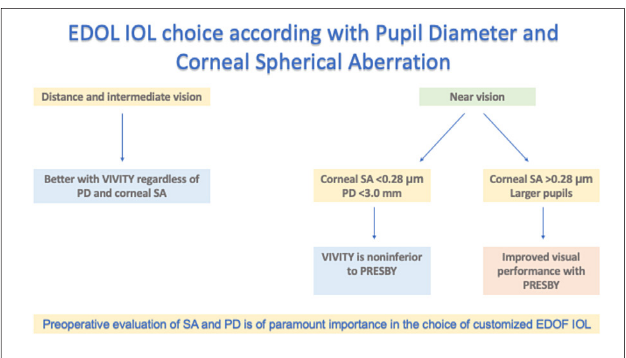

Figure 8. Proposed algorithm for EDOF IOL choice according with corneal spherical aberration and pupil diameter.

DISCUSSION

Standardized defocus curves are a useful tool to accurately determine visual acuity between different IOLs at each defocus level.[19–21] Our study compared the defocus curves of two presbyopia correcting IOLs with different optic designs. Specifically, we provide novel evidence regarding visual performance over a continuous range from 6 m to 33 cm. Its stratification by SA and PD allows a customized approach to select a specific IOL for each eye's optical profile.

There were no significant preoperative differences over both groups, thereby allowing its comparison.

Despite both IOLs showing excellent DCVA at 6 m, the VIVITY showed better visual performance (p=0.011). It may reflect increased and more efficient energy distribution over distance.[16,22] However, it should be noted that this difference is probably clinically irrelevant and beyond the scope of this study.

Despite both groups fulfilling criteria for EDOF IOLs,[23] intermediate vision (67-100 cm) was significantly better with the VIVITY, especially with smaller pupils. This was not surprising, as the IOL's extended focal range allows for clear vision up to a defocus of -1.75 D until collapsing. On the other hand, despite promotion as a continuous transitional focus, the PRESBY behaves as a sectorial bifocal refractive IOL. This also explains its best performance in near vision – its refractive optic rings have a power addition of +2.75 D, allowing for improved near vision. However, intermediate vision may be favored by less negative SA.

Our work proved the benefit of smaller pupils in near vision for eyes implanted with VIVITY, which probably reflects the Stiles-Crawford's effect (light entering the eye near the pupil center produces a higher photoreceptor response compared with light entering near the pupil margin) applied to the optics' central plateau, enhancing wavefront stretching. On the other hand, it appears to occur no relevant modulation in near vision with smaller pupils in the PRESBY (which is advertised by the manufacturer),[18] reflecting the closely spaced multiple focal points for near vision.

This study shows the effect of corneal SA modulation in near vision, since patients with more negative SA show improved near optical performance in the VIVITY group. The cornea's prolate shape partially compensates for an average corneal SA of +0.31 μm in the general population.[24] When negative, central rays are focused anterior to peripheral rays. We believe this effect acts synergically with VIVITY's central plateau for near vision. Thus, the net effect is improved near vision in eyes with more negative SA.

On the other hand, there appears to be a reverse correlation between SA and near performance in the PRESBY group, which may be of interest in eyes with less negative SA. When positive, peripheral rays are focused anterior to central rays. Since PRESBY has no central near vision refractive segments, peripheral ones are enhanced by positive SA, thereby improving near vision.

We believe these findings are clinically very relevant and we propose an algorithm for EDOF IOL choice based on each eye's optical system: patients with smaller pupils can benefit in near vision after VIVITY implantation, while retaining intermediate vision and reduced photic phenomena.

We propose a customized approach (Fig. 8) based on PD and SA to maximize near vision performance: VIVITY may be a better option with decreasing PD (<3.0 mm) and corneal SA (<0.28 μm). More positive corneal SA (>0.28 μm) seems to positively influence near vision after PRESBY implantation, even with larger pupil diameters. Additionally, patients with increased SA (such as after myopic laser vision correction[25]) may still exhibit good near vision with PRESBY implantation.

Our study has limitations. We evaluated patients previously submitted to surgery, so their allocation was not formally random. However, both groups are paired regarding SA and PD, which minimizes bias. Defocus curve testing was performed at different timings after IOL implantation (which may be biased by IOL glistening) and after posterior capsulotomy (which may induce IOL decentration).

Our population comprised 46 losses – 26 (34.2%) in VIVITY and 20 (29.0%) in PRESBY groups. Despite this relatively high rate, it is comparable among groups, avoiding selection bias. Despite not knowing their outcomes, most patients were satisfied at the first postoperative appointments. It seems reasonable to assume that unsatisfied patients were more prone to attend additional follow-up. If this assumption is correct, there is a risk that real-life results are better than those reported in this study.

However, our methodology was robust with an objective study protocol. We gathered a large sample of well-selected patients and introduced clinically relevant information to the scientific community.

In conclusion, this study reinforced the efficacy of two different IOLs in the correction of presbyopia. We also proved the real-life benefit in near vision after implantation of the VIVITY in patients with smaller pupils and less

positive SA. On the other hand, the PRESBY may be considered for patients with higher near-vision requirements, especially those with larger pupils and more positive SA.

CONTRIBUTORSHIP STATEMENT / DECLARAÇÃO DE CONTRIBUIÇÃO

All the authors contributed substantially to the conception, design of the work, acquisition, analysis and interpretation of the data for the work; writing, critical revision and final approval of the version to be published.

Todos os autores contribuiram substancialmente para a conceção, desenho do trabalho, aquisição, análise e interpretação dos dados para o trabalho; redação, revisão crítica e aprovação final da versão a ser publicada.

RESPONSABILIDADES ÉTICAS

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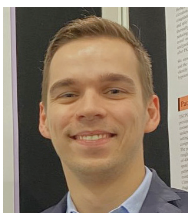

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