COMPARISON OF EARLY VISION QUALITY OF SBL-2 AND SBL-3 SEGMENTED REFRACTIVE LENS

Ratajová Michaela[1], Hoppeová Veronika[1], Janeková Andrea[1,2]

[1]Eye Centre Prague, a.s., Czech Republic
[2]Faculty of Medicine, Charles University Hradec Králové, Czech Republic

The authors of the study declare that no conflict of interests exists in the compilation, theme and subsequent publication of this professional communication, and that it is not supported by any pharmaceuticals company. The study has not been submitted to any other journal or printed elsewhere.

Submitted to the editorial board: December 6, 2023
Accepted for publication: January 25, 2024
Available on-line: March 15, 2024

MUDr. Michaela Ratajová
Oční centrum Praha, a.s.
Holešovice 1637
170 00 Praha 7
E-mail: michaela.ratajova@ocp.cz

SUMMARY

Purpose: To compare objective quality of vision in patients undergoing phacoemulsification with implantation of a bilateral segmented multifocal intraocular lens (SMIOL).

Methods: A retro-prospective study included 110 eyes of 55 patients who underwent cataract surgery with bilateral SMIOL implantation. Patients were divided according to the type of implanted intraocular lens into group 1 (SBL-2, 62 eyes) and group 2 (SBL-3, 48 eyes). Postoperatively, monocular and binocular uncorrected distance visual acuity (UCDVA), corrected distance visual acuity (BCDVA), uncorrected intermediate visual acuity (UCIVA, at 66 cm), uncorrected near visual acuity (UCNVA, at 40 cm), corrected near visual acuity (BCNVA) and defocus curve were measured and evaluated. The follow-up period was 6 months.

Results: Mean UCDVA in group 1 (SBL-2) was 0.010 ±0.15 LogMAR monocularly, 0.01 ±0.10 LogMAR binocularly, and in group 2 (SBL-3) was 0.02 ±0.11 LogMAR monocularly and -0.07 ±0.09 LogMAR binocularly. Binocular defocus curves showed that the SBL-3 group performed better than the SBL-2 lens at a vergence of -1.50 D corresponding to 66 cm (center distance), averaging 0.03 ±0.11 LogMAR, while the SBL-2 group averaged 0.12 ±0.14 LogMAR (p = 0.01). The -2.50 D vergence characterizing near vision (40 cm) was achieved by the SBL-2 lens in our study at 0.33 ±0.15 LogMAR and by the SBL-3 lens at 0.00 ±0.11 LogMAR (p = 0.00).

Conclusion: Both SMIOLs provided very good vision at all tested distances 6 months postoperatively. The SBL-2 lens performed better in UCIVA, while the SBL-3 lens excelled in UCDVA and UCNVA.

Key words: rotationally asymmetric multifocal intraocular lens, bifocal, cataract, visual acuity, defocus curve

Čes. a slov. Oftal., 80, 2024, No. 2, p. 93–100

INTRODUCTION

Due to lifestyle changes at a more advanced age and in connection with the incidence of presbyopia and cataract, attention is increasingly focusing on the implantation of multifocal intraocular lenses, which are thereby coming to the forefront of interest of modern ophthalmology. With growing patient demands for preservation of quality vision at all distances after surgery, there has been an expansion of the offer of individual intraocular lenses capable of providing quality vision also at higher ages, and maintaining independence from spectacles correction.

The first multifocal intraocular lens (MIOL) of its type for the correction of presbyopia was first implanted in a human in 1986, and over the course of the last few decades its technology has advanced precipitously [1]. MIOLs provide quality distance vision, and thanks to the change of physiological division of light entering the eye into several focal points also enable better intermediate and near vision [2]. At the same time, the available studies also reflect the limitations of MIOLs, such as unsatisfactory uncorrected intermediate visual acuity (UCIVA) and optic side effects such as glare, halo and a reduction of contrast sensitivity [3,4]. In an endeavor to alleviate these effects, manufacturers of IOLs have targeted an improvement of the optic design of MIOLs. A condition for achieving the desired result remains thorough preoperative examination of the patient, including communication of the patient's visual requirements [5].

A diverse offer of MIOLs is currently available on the market, which according to the construction of the optic surface can be divided into diffractive, refractive and a combination of both types [6]. The difference consists in the passage of light through the optics, causing its refraction, bending or both, both for distance and near vision, and moreover part of the light is dispersed [2]. Diffractive optics are composed of a number of concentric rings on the surface of the lens, the distance between which decreases towards the periphery. The diffractive rings utilize the wave nature of light, in which its refraction and interference takes place. The main deficiency is a loss of energy of light rays upon the passage through the diffractive surface, which leads to subjective feelings of a deterioration of contrast sensitivity. Due to the multiple diffractive structure of the optics, a halo effect and glare occur more frequently. The resulting vision is not limited by pupil width, and is less dependent on the precise centration of the lens. In the case of refractive optics, this concerns zonal configuration in which a number of zones with various optical density and refractiveness alternate, corresponding to distance and near vision. Refractive intraocular lenses are sensitive to pupil width and precise centration of the lens [1,2,6]. According to the number of focal points in which the light converges after passage through the lens, it is possible to categorize lenses into bifocal and trifocal (panfocal) [1]. The optics may also be constructed as rotationally symmetrical (composed of concentric rings, all diffractive models and most refractive lenses), or rotationally asymmetrical (segmented zones for distance vision and the lower segment with addition for near vision, certain refractive models) [1,2,6].

Growing patient demands and the emphasis placed on quality of vision especially for intermediate distance (desktop computer, cellphones) has led to an increase in the availability of lenses with extended depth of focus (EDOF) [5], trifocal lenses [7] and the introduction of a design of optics with reduced addition for near vision in existing MIOLs [6].

Intraocular lenses SBL-2 and SBL-3 (both Lenstec, Inc. Christ Church, Barbados) are bifocal asymmetrical segmented IOLs, the optical surface of which combines two segments. The upper distance sector and the lower 2.00 diopter (D) segment in the case of SBL-2 and the 3.00 D segment in the SBL-3 are embedded in the anterior surface of the IOL. Both segments are separated by a small transitional wedge-shaped zone [3,9]. The smaller number of transitional zones in comparison with the rotationally symmetrical design of the optics is intended to lead to smaller losses of energy, better quality of near vision and contrast sensitivity [10]. The recommended positioning of the IOL in the bag is the segment for near vision inferonasally, ideally so that the visual axis does not pass through the segment for near vision or the transitional zone. This position should minimize any potential adverse optic phenomena. According to requirement the lens can be rotated, with positioning of the segment for near vision in any position without an influence on near vision. This is a hydrophilic acrylate IOL with an aberration-neutral profile, optic diameter of 5.75 mm and total length of 11.00 mm. The lenses are available within the range from +10.00 D to +36.00 D at intervals of 0.50 D, and in the range from +15.00 D to +25.00 D at intervals of 0.25 D.

The aim of the study was to compare distance, intermediate and near visual acuity in a group of patients with the implanted bifocal asymmetrical segmented IOL SBL-2 and a group with the intraocular IOL SBL-3 after a follow-up period of 6 months from implantation, and to evaluate the defocus curve of both groups.

MATERIAL AND METHODS

The retro-prospective, monocentric, non-randomized comparative study included 110 eyes of 55 patients who underwent phacoemulsification cataract surgery combined with SMIOL implantation (Fig. 1). The preoperative data of the patients were collected retrospectively, and one prospective visit was organized postoperatively in order to obtain the observed data. Two groups were classified according to the type of implanted SMIOL: group 1 (SBL-2), incorporating 62 eyes, and group 2 (SBL-3), incorporating 48 eyes. The inclusion criterion was patients with age-related cataract in both eyes, preoperative astigmatism less than 1.00 D, with planned implantation of an SMIOL within the range of 15.00 D to 30.00 D, with absence of any ocular or general comorbidities that could influence the result of vision. The exclusion criteria included astigmatism larger than 1.00 D, medical history of previous refractive or other corneal surgery, corneal pathology (inflammation, edema, decompensation, dystrophy), preoperative photopic pupil size smaller than 3.00 mm, pupil abnormalities such as ectopia, neovascularization or atrophy of the iris, glaucoma, chronic uveitis or atrophy of the optic nerve.

All the patients were well informed regarding the procedure, the implanted IOL, and signed an informed con-

Figure 1. SBL-3 intraocular lens

sent form in accordance with the Helsinki Declaration. They subsequently underwent phacoemulsification with SMIOL implantation into the capsular bag, and attended all the planned follow-ups.

Preoperative examination

Before surgery the patients underwent a thorough ocular examination comprising determination of uncorrected and corrected distance visual acuity, manifest refraction, examination on a slit lamp, examination of the ocular fundus via a dilated pupil, corneal topography (Pentacam, Oculus GmbH, Wetzlar, Germany) and biometry performed with the aid of the instrument Lenstar LS 900 (Haag-Streit AG, Switzerland) recording keratometry, anterior chamber depth (ACD), axial length (AL) of the eye and pupil width. All the patients underwent an OCT examination in order to exclude retinal pathology (Optovue, Inc., Freemont, CA). The refractive target was emmetropia, and the selection of the lens was performed with the aid of the SRK/T formula.

Surgical technique

All the operations were performed with the use of topical anesthesia, followed by a 2.2 mm corneal incision with superior or temporal location according to the preference of the surgeon. A 5–5.5 mm continuous circular capsulorhexis was created, and after phacoemulsification of the lens the SMIOL was implanted into the capsular bag. In both groups of patients, the IOL was positioned so that the near segment of the lens was oriented inferonasally. No perioperative complications were recorded. Preoperative medication was composed of a combination of the local antibiotic levofloxacin and the anti-inflammatory steroid dexamethasone, and patients also applied the non-steroid antiphlogistic bromfenac.

Postoperative examination

At an interval of six months after surgery, the following were evaluated at the center of the author of the study: uncorrected distance visual acuity (UCDVA), uncorrected intermediate visual acuity (UCIVA), corrected near visual acuity (CNVA), and the defocus curve was recorded. All the evaluations of visual acuity were measured with the aid of a logarithm of graphs with the minimal angle of resolution (logMAR) under photopic lighting for a distance of 4 m, and with the aid of a graph of the early treatment diabetic retinopathy study (ETDRS) for intermediate and near vision (66 cm and 40 cm). Routine observation was performed for healing of the ocular wounds, inflammatory reactions of the anterior chamber, state of the pupil and position of the IOL.

After determination of BCDVA, defocus curves were constructed in order to assess expected visual acuity, within the range of +2.00 D to -5.00 D, in which the foreplacement of a minus spherical lens of 1.50 D represents vision to an intermediate distance (66 cm), whereas -2.50 D corresponds to near vision (40 cm).

Statistical analysis

The statistical analysis was performed with the aid of the software IBM SPSS for Windows (version 19, SPSS, Inc,), and the software Microsoft Excel (Microsoft Corp.). The normality of the tested variables was performed with the aid of a Shapiro-Wilk test, with subsequent secondary testing with the aid of histograms and values of inclination and peaking of the distribution of variables. In the case of a normal distribution of data a Student's t-test

Table 1. Demographic and preoperative patient data

Parameter	Mean of group 1 (SBL-2) ±SD (range)	Mean of group 2 (SBL-3) ±SD (range)	p value
Number of eyes (patients)	62 (31)	48 (24)	
Men/Women (n)	13/18	14/10	
Age (years) ±SD	72.42 ±5.12 (58 to 82)	63.38 ±6.33 (50 to 74)	0.00*
UCDVA (LogMAR) ±SD	0.42 ±0.23 (0.10 to 1.00)	0.53 ±0.22 (0.04 to 0.78)	0.00*
BCDVA (LogMAR) ±SD	0.20 ±0.16 (0.00 to 0.90)	0.19 ±0.15 (-0.10 to 0.62)	0.98
Pre-Op Sph ±SD	0.16 ±1.60 (-4.00 to 2.75)	0.19 ±2.37 (-5.00 to 3.25)	0.27
Pre-Op Cyl ±SD	-0.17 ±0.42 (-2.00 to 0.50)	-0.39 ±1.04 (-2.00 to 1.00)	0.30
SE (D) ±SD	0.02 ±1.65 (-4.00 to 2.75)	0.13 ±2.34 (-5.00 to 3.25)	0.35
AL (mm) ±SD	23.65 ±0.76 (22.40 to 25.55)	23.55 ±1.04 (21.62 to 25.45)	0.59
K1 (D) ±SD	43.07 ±1.31 (39.42 to 45.41)	43.37 ±1.57 (40.76 to 47.40)	0.21
K2 (D) ±SD	43.46 ±1.34 (39.97 to 46.29)	43.98 ±1.54 (41.51 to 48.08)	0.06
ACD (mm) ±SD	3.25 ±0.30 (2.66 to 3.87)	3.14 ±0.38 (2.50 to 3.93)	0.09
IOL power (D) ±SD	20.20 ±1.75 (16.50 to 25.00)	20.73 ±2.51 (15.00 to 25.00)	0.22

Evaluation using Student's t-test and Mann-Whitney test, p value expresses the result of individual tests comparing group 1 and 2
** – indicates a statistically significant result, SD – standard deviation, UCDVA – uncorrected distance visual acuity, BCDVA – corrected distance visual acuity, Pre-Op Sph – pre-operative value of spherical diopters, Pre-Op Cyl – pre-operative value of cylindrical diopters, SE – spherical equivalent, D – diopter, LogMAR – logarithm of minimum angle of resolution, AL – axial length of the eye, K1– flat meridian of keratometry, K2 – steep meridian of keratometry, ACD – anterior chamber depth, IOL power – power of the implanted intraocular lens*

was used for testing differences between the groups, in the opposite case a Mann-Whitney test not requiring normality of data was selected. The same level of significance was stipulated for all the statistical tests (p = 0.05).

RESULTS

All the patients (55 patients, 110 eyes) underwent a follow-up examination 6 months after cataract surgery, and according to the implanted lens were divided into two groups: group 1 (SBL-2) and group 2 (SBL-3). The preoperative and demographic data of the patients is summarized in Table 1. Statistically significant differences were determined in patient age (Student t-test, p = 0.00) and in the values of LogMAR UCDVA (Mann-Whitney test, p = 0.00), the other parameters did not differ statistically significantly (Student t-test, Mann-Whitney test, p > 0.06).

Table 2 summarizes the refractive and visual results 6 months after surgery. In both groups a marked improvement of UCDVA was recorded in comparison with the preoperative data. Statistically significant differences were found between the groups for SE, monocular UCDVA, BCDVA, UCIVA, UCNVA, DCIVA, DCNVA and binocular UCDVA, BCDVA, UCIVA, UCNVA, DCNVA, BCNVA (all Mann-Whitney test, p < 0.01). No statistically significant differences between the groups were found in the parameters of binocular DCIVA (Mann-Whitney test, p = 0.09) and monocular BCNVA (Mann-Whitney test, p = 0.49).

Cumulative monocular and binocular UDCVA of both groups of patients is illustrated in Graph 1, in which 0.0 LogMAR or better was attained by 44% of eyes monocularly and 77% binocularly in group SBL-2, and 50% of eyes monocularly and 88% of eyes binocularly in group SBL-3.

Graph 2 evaluates cumulative UCIVA, both monocularly and binocularly, with a comparison of both groups. Values of 0.0 LogMAR or better were attained by 56% of eyes monocularly and 87% of eyes binocularly in group SBL-2, and 15% of eyes monocularly and 46% of eyes binocularly in groups SBL-3.

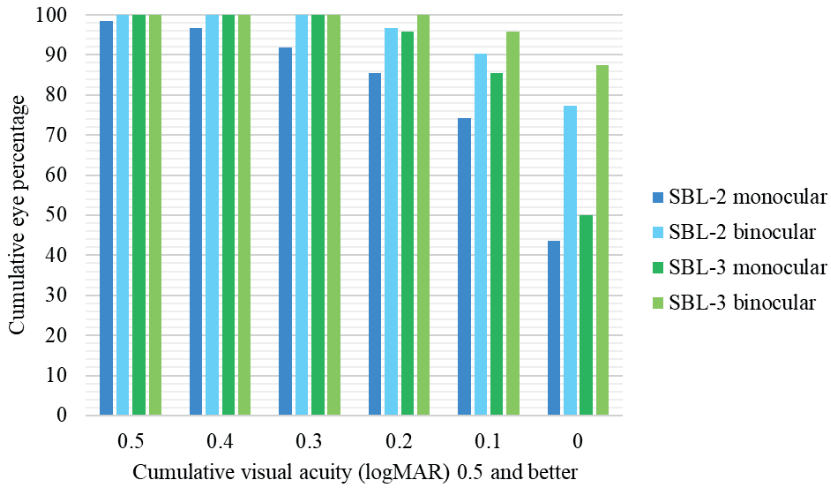
Cumulative monocular and binocular UNCVA in groups 1 and 2 is illustrated in Graph 3. Values of visual acuity of 0.20 LogMAR or better were attained by 61% of eyes monocularly and 84% of eyes binocularly in group 1 (SBL-2). In group 2 (SBL-3) the results were better, specifically 92% of eyes monocularly and 100% of eyes binocularly.

The defocus curve was measured for all patients as part of the examination at an interval of 6 months after cataract surgery. The mean defocus curve in the patients analyzed in this study is presented in Graph 4. As illustrated in the graph, although it is a bifocal lens, the SBL-2 curve does not have two peaks corresponding to distance and near vision, but after attaining maximal visual acuity (0.0 LogMAR at 0 D) progressively falls. The SBL-3 curve retains a bimodal profile (the mean values of visual acuity attain a maximum of 0.0 LogMAR at 0.00 D and -0.02 LogMAR at -2.00 D). In our study, at a vergence of -1.50 D corresponding to 66 cm (center distance), mean visual acuity of was attained at 0.12 ±0.16 LogMAR in the case of the lens SBL-2 and at 0.03 ±0.11 LogMAR in the case of the SBL-3 lens. The -2.50 D vergence characterizing near vision (40 cm) was achieved by the SBL-2 lens

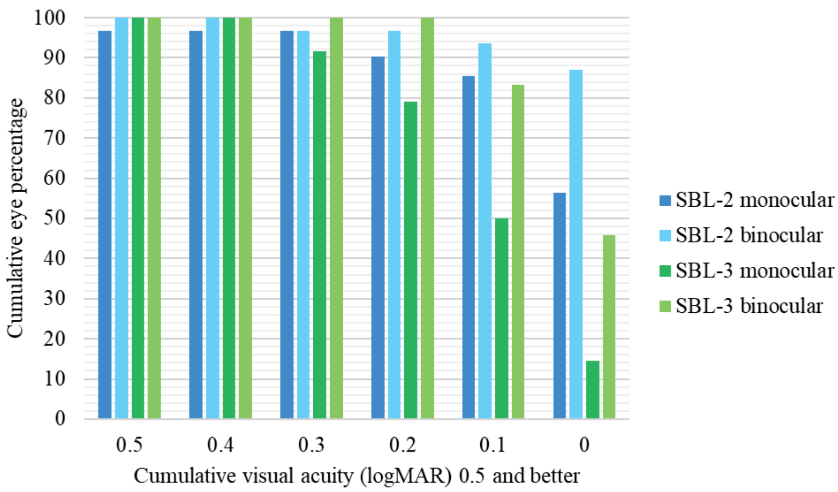
Table 2. Postoperative visual and refractive outcomes 6 months after cataract surgery

Parameter	Mean of group 1 (SBL-2) ±SD (range)	Mean of group 2 (SBL-3) ±SD (range)	p value
Monocular UCDVA (LogMAR)	0.10 ±0.15 (-0.10 to 0.60)	0.02 ±0.11 (-0.24 to 0.30)	0.01*
Binocular UCDVA (LogMAR)	0.01 ±0.10 (-0.20 to 0.30)	-0.07 ±0.09 (-0.24 to 0.14)	0.01*
SE	-0.10 ±0.42 (-1.38 to 1.50)	0.02 ±0.36 (-1.50 to 0.50)	0.01*
Monocular BCDVA (LogMAR)	0.03 ±0.10 (-0.10 to 0.40)	-0.03 ±0.08 (-0.24 to 0.16)	0.00*
Binocular BCDVA (LogMAR)	-0.01 ±0.10 (-0.20 to 0.30)	-0.09 ±0.07 (-0.24 to 0.06)	0.00*
Monocular UCIVA 66 cm (LogMAR)	0.07 ±0.16 (-0.20 to 0.80)	0.16 ±0.12 (-0.10 to 0.40)	0.00*
Binocular UCIVA 66 cm (LogMAR)	-0.04 ±0.13 (-0.20 to 0.40)	0.05 ±0.10 (-0.20 to 0.20)	0.00*
Monocular UCNVA 40 cm (LogMAR)	0.24 ±0.23 (0.00 to 1.00)	0.09 ±0.13 (-0.10 to 0.50)	0.00*
Binocular UCNVA 40 cm (LogMAR)	0.13 ±0.18 (0.00 to 0.70)	0.00 ±0.10 (-0.10 to 0.20)	0.00*
Monocular DCIVA 66 cm (LogMAR)	0.08 ±0.14 (-0.20 to 0.40)	0.14 ±0.12 (-0.10 to 0.40)	0.01*
Binocular DCIVA 66 cm (LogMAR)	-0.02 ±0.11 (-0.20 to 0.20)	0.03 ±0.10 (-0.20 to 0.20)	0.09
Monocular DCNVA 40 cm (LogMAR)	0.27 ±0.24 (0.00 to 1.00)	0.06 ±0.12 (-0.10 to 0.50)	0.00*
Binocular DCNVA 40 cm (LogMAR)	0.16 ±0.19 (0.00 to 0.70)	-0.02 ±0.08 (-0.10 to 0.10)	0.00*
Monocular BCNVA 40 cm (LogMAR)	0.01 ±0.05 (0.00 to 0.30)	0.03 ±0.10 (-0.10 to 0.30)	0.49
Binocular BCNVA 40 cm (LogMAR)	0.01 ±0.04 (0.00 to 0.20)	-0.03 ±0.07 (-0.10 to 0.10)	0.01*

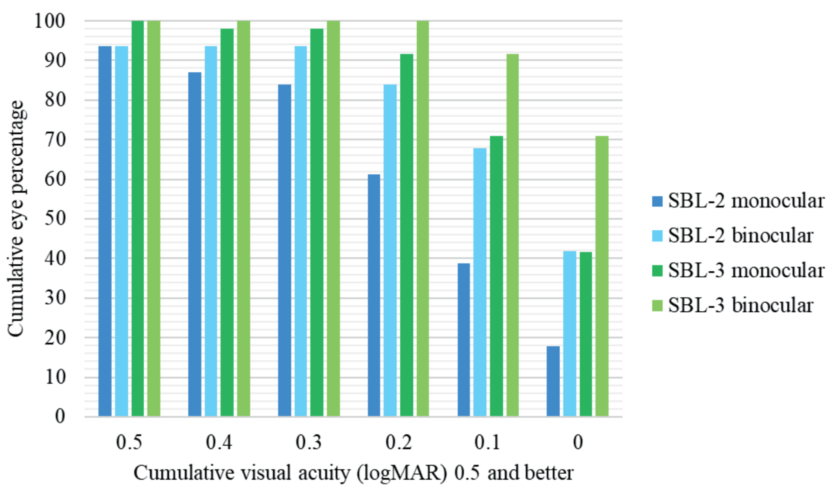
Evaluation using Student's t-test and Mann-Whitney test, p value expresses the result of individual tests comparing group 1 and 2
** – indicates a statistically significant result, SD – standard deviation, UCDVA – uncorrected distance visual acuity, BCDVA – corrected distance visual acuity, SE – spherical equivalent, LogMAR – logarithm of the minimum angle of resolution, UCIVA – uncorrected intermediate visual acuity, UCNVA – uncorrected near visual acuity, DCIVA – distance-corrected central visual acuity, DCNVA – corrected near visual acuity with distance correction, BCNVA – corrected near visual acuity*



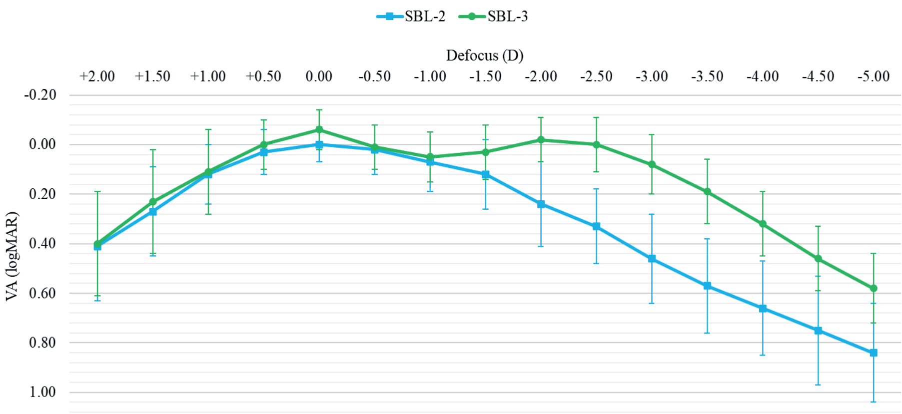
Graph 1. Cumulative Uncorrected Distance Visual Acuity (UCDVA)
UCDVA – uncorrected distance visual acuity, LogMAR – logarithm of the minimum angle of resolution



Graph 2. Cumulative Uncorrected Intermediate Distance Visual Acuity (UCIVA)
UCIVA – uncorrected intermediate distance visual acuity, LogMAR – logarithm of the minimum angle of resolution



Graph 3. Cumulative Uncorrected Near Visual Acuity (UCNVA)
UCNVA – uncorrected near visual acuity, LogMAR – logarithm of the minimum angle of resolution



Graph 4. Defocus curve
VA – visual acuity, LogMAR – logarithm of the minimum angle of resolution, D – diopter

in our study at 0.33 ±0.15 LogMAR and by the SBL-3 lens at 0.00 ±0.11 LogMAR. Statistically significant differences of both groups were found on the level of defocusing of 0.00 D and also on the level of defocusing of -1.50 D to -5.00 D (Mann-Whitney test, $p < 0.01$).

DISCUSSION

Following cataract surgery, the main goal is restoration of visual functions, which is nevertheless dependent to a large extent on the choice of intraocular lens [11]. In the case of rotationally symmetrical MIOLs, quality of vision has been demonstrated by a series of studies [12,13], although at the same time numerous subjective patient complaints have been reported in the form of the incidence of secondary optic phenomena such as halo and glare, which may negatively influence the potential benefit of these types of IOL [4,12]. With the aim of minimizing these side effects, rotationally asymmetrical MIOLs have been introduced to the market, which in terms of quality of postoperative vision can compete with several diffractive models [3,9] and at the same time also demonstrate better results of contrast sensitivity in comparison with diffractive MIOLs [14].

The first models of asymmetrical MIOLs originated from the Lentis Mplus range, which was later followed by the Lentis Comfort range (Teleon Surgicall BV, Spankeren, Netherlands, formerly Oculentis GmbH, Berlin, Germany), and are available in a wide range of types with various additions for near vision [15]. Another manufacturer of asymmetrical segmented bifocal IOLs is Lenstec (Lenstec, Inc. Christ Church, Barbados), whose offer is composed of two types of IOL, namely SBL-2 and SBL-3 [6,9]. By contrast with Lentis Mplus and Comfort, Lenstec IOLs have the segment for near vision positioned closer to the periphery of the optics. Its expansion may be the cause of improvement of intermediate distance vision and the reduction of dysphotopsias while maintaining good distance and near visual acuity [16,17].

A significant improvement of UCDVA was demonstrated in both groups in comparison with the preoperative data, both monocularly and binocularly. In the SBL-2 group the mean value of UCDVA was 0.10 ±0.15 LogMAR monocularly and 0.01 ±0.10 LogMAR binocularly, in the case of the SBL-3 lens the values of UCDVA were 0.02 ±0.11 LogMAR monocularly and -0.07 ±0.09 LogMAR binocularly, as presented in Table 2. However, the difference between the groups was evaluated as statistically significant in favor of group SBL-3, which provides better values of distance visual acuity in comparison with the other group (Mann-Whitney test, $p < 0.01$). These results confirm the effectiveness of the MIOL as a tool for quality restoration of vision of aphakic patients. Similarly high-quality results with the SBL-3 intraocular lens were attained by the authors McNeely et al. [16,17] in their studies, when in the case of prospective observation, they evaluated postoperative visual acuity in 50 patients following bilateral implantation of the IOL SBL-3. Values of UCDVA were -0.02 ±0.12 LogMAR monocularly 3 months after surgery and -0.01 ±0.01 LogMAR after 12 months [17]. The same authors then retrospectively compared the results of two groups of patients with bilateral implantation of an SMIOL with 3.00 D addition for near vision (SBL-3 and Lentis Mplus LS-312 MF30), in which both lenses provided high quality of distance vision [16]. Venter et al. [6] in their study presented the results of an SMIOL with addition for near vision (SBL-2), in which UCDVA was 0.02 ±0.12 LogMAR monocularly and -0.04 ±0.08 LogMAR binocularly. However, a limitation of this study is the retrospective design and the short observation period of only 2 months after surgery.

As in our study, in which the group with the SBL-2 intraocular lens attained very high-quality uncorrected results at intermediate distance and thus presented a statistically significant difference in comparison with the SBL-3 group, Venter et al. also confirmed the functionality of this lens with monocular UCIVA of 0.08 ±0.15 LogMAR and binocular UCIVA of 0.04 ±0.14 LogMAR [6]. The attainment of quality results in the case of bifocal lenses at intermediate distance in comparison with diffractive MIOLs has already been demonstrated in other studies [3,9]. A cause of the statistically significant difference in intermediate distance vision between the observed groups may be the chosen examination distance; in our study measurement with the aid of a graph of the early treatment diabetic retinopathy study (ETDRS) at 66 cm was used, whereas in other studies a distance of 80 cm was chosen in the case of the SBL-3 lens [3,9].

In comparison with the attained postoperative values for distance and intermediate vision, according to expectation the obtained values for near vision are less satisfactory in the SBL-2 group, whereas measured visual acuity in the SBL-3 group attained better results. The measured values are in accordance with the data presented by other authors concentrating on the postoperative results of SMIOL [3,6,9,16,17]. The measured values of near visual acuity in both groups are adequate for reading larger sized text, but in the case of the SBL-2 group further correction is necessary for comfortable reading of smaller print. Studies focusing on an asymmetrical multifocal lens with lower addition for near vision +1.50 D (Lentis 313 MF15) document quality distance and intermediate vision, and only functional to inadequate results of near visual acuity [18–20]. In the case of Oshika T. et al., the mean values were UCDVA 20/20, UCIVA 20/25 and UCNVA 20/60 [18]. In the study by Kretz FT et al. the postoperative results for distance vision attained mean UCDVA of 0.00 LogMAR, quality intermediate distance with mean UCIVA of 0.01 LogMAR at 80 cm and functional values for near vision (mean UCNVA of 0.41 LogMAR at 40 cm) [19]. Similarly, Pedrotti E et al. measured mean UCDVA of -0.01 LogMAR, UCIVA at 70 cm 0.05 LogMAR and UCNVA of only 0.54 LogMAR at 30 cm [20]. The results of our study document that higher addition in rotationally asymmetrical lenses provides lesser to no requirement of reading aids for quality near vision.

Defocus curves serve for the assessment of the visual performance of the individual types of lenses, in which in the case of MIOL we expect two peaks of maximum vision of 2.50 D defocusing (equivalent to 40 cm observation distance from eye) and 0.00 D (equivalent distance vision). In our study, upon measurement of the defocus curve we describe the attainment of only one peak and a subsequent decrease in the case of the SBL-2 lens, while attainment of the highest values of visual acuity in the area of the level of defocusing is 0.00 D. In the case of the SBL-3 lens we measured a bimodal profile with maximum of measured values on the level of defocusing of 0.00 D and -2.00 D, corresponding to a distance of 50 cm (Graph 4). Previous studies of rotationally asymmterical lenses with lower addition document similar a finding of the defocus curve as in the case of the SBL-2 lens in our observation [18,19], while by contrast in the case of the SBL-3 with higher addition we came to a similar conclusion of the bimodal character of the curve, as mentioned above [3,21].

Also important for quality of vision following the implantation of an asymmetrical MIOL is decentration and tilt of the MIOL, in which the target is positioning of the near segment inferonasally. Upon examination using a slit lamp via a dilated pupil, no decentration or tilt of the MIOL was recorded. No intraoperational complications were recorded in the entire cohort of patients, within the framework of postoperative complications 1 case of postoperative anterior uveitis was recorded in the SBL-2 group, which was resolved by conservative therapy (tropicamide + dexamethasone). During the first 6 months after surgery, 11 cases of opacification of the posterior capsule were recorded, for which Nd:YAG laser capsulotomy was performed (8 cases in the SBL-2 group and 3 cases in the SBL-3 group).

CONCLUSION

In conclusion it is possible to state that multifocal rotationally asymmetrical lenses provide excellent distance and intermediate vision, and satisfactory near vision without the need to use reading aids for larger sized text. The SBL-3 lens demonstrated better binocular UCDVA and UCNVA, which is due to the higher addition in the lower segment of the optical part of the lens in comparison with the SBL-2 lens, which in our study demonstrated better values of binocular UCIVA.

A limitation of this study is the small number of observed subjects and the relatively short observation period, which is necessary for an evaluation of refractive stability and subjective patient satisfaction after the process of neuroadaptation. Another limitation of the study is the unavailability of results of measurement of contrast sensitivity for both groups.

REFERENCES

1. Sieburth R, Chen M. Intraocular lens correction of presbyopia. Taiwan J Ophthalmol. 2019 Jan-Mar;9(1):4-17.
2. Salerno LC, Tiveron MC Jr, Alió JL. Multifocal intraocular lenses: Types, outcomes, complications and how to solve them. Taiwan J Ophthalmol. 2017 Oct-Dec;7(4):179-184.
3. Wang X, Tu H, Wang Y. Comparative Analysis of Visual Performance and Optical Quality with a Rotationally Asymmetric Multifocal Intraocular Lens and an Apodized Diffractive Multifocal Intraocular Lens. J Ophthalmol. 2020 Apr 20;2020:7923045.
4. Woodward MA, Randleman JB, Stulting RD. Dissatisfaction after multifocal intraocular lens implantation. J Cataract Refract Surg. 2009 Jun;35(6):992-7.
5. Sachdev GS, Sachdev M. Optimizing outcomes with multifocal intraocular lenses. Indian J Ophthalmol. 2017 Dec;65(12):1294-1300.
6. Venter JA, Collins BM, Hannan SJ, Teenan D, Schallhorn JM. Outcomes of a Refractive Segmented Bifocal Intraocular Lens with a Lower Near Addition. Clin Ophthalmol. 2022 Aug;16:2531-2543.
7. Xu Z, Cao D, Chen X, Wu S, Wang X, Wu Q. Comparison of clinical performance between trifocal and bifocal intraocular lenses: A meta-analysis. PLoS One. 2017 Oct 26;12(10):e0186522.
8. Zhao J, Liu LP, Cheng HH et al. Accuracy of eight intraocular lens power calculation formulas for segmented multifocal intraocular lens. Int J Ophthalmol. 2020 Sep 18;13(9):1378-1384.
9. Lian H, Ma W, Wei Q, Yuan X. A comparative study on early vision quality after implantation of refractive segmental and diffractive multifocal intraocular lens. Pak J Med Sci. 2020 Nov-Dec;36(7):1607-1612.

10. Hui N, Chu MF, Li Y, Wang CY, Yu L, Ma B. Comparative analysis of visual quality between unilateral implantation of a trifocal intraocular lens and a rotationally asymmetric refractive multifocal intraocular lens. Int J Ophthalmol. 2022 Sep 18;15(9):1460-1467.
11. Gil-Cazorla R, Shah S, Naroo SA. A review of the surgical options for the correction of presbyopia. Br J Ophthalmol. 2016 Jan;100(1):62-70.
12. Serdiuk V, Ustymenko S, Fokina S, Ivantsov I. Comparison of three different presbyopia-correcting intraocular lenses. Rom J Ophthalmol. 2020 Oct-Dec;64(4):364-379.
13. Modi S, Lehmann R, Maxwell A, et al. Visual and Patient-Reported Outcomes of a Diffractive Trifocal Intraocular Lens Compared with Those of a Monofocal Intraocular Lens. Ophthalmology. 2021 Feb;128(2):197-207.
14. Alió JL, Plaza-Puche AB, Montalban R, Javaloy J. Visual outcomes with a single-optic accommodating intraocular lens and a low-addition-power rotational asymmetric multifocal intraocular lens. J Cataract Refract Surg. 2012 Jun;38(6):978-85.
15. Veliká V, Hejsek L, Raiskup F. Clinical Results of Implantation of Two Types of Multifocal Rotationally – Asymmetric Intraocular Lenses. Cesk Slov Oftalmol. 2017;73(1):3-12. Available from: https://www.cs-ophthalmology.cz/en/journal/articles/13
16. McNeely RN, Pazo E, Spence A et al. Visual quality and performance comparison between 2 refractive rotationally asymmetric multifocal intraocular lenses. J Cataract Refract Surg. 2017 Aug;43(8):1020-1026.
17. McNeely RN, Pazo E, Spence A et al. Visual outcomes and patient satisfaction 3 and 12 months after implantation of a refractive rotationally asymmetric multifocal intraocular lens. J Cataract Refract Surg. 2017 May;43(5):633-638.
18. Oshika T, Arai H, Fujita Y, et al. One-year clinical evaluation of rotationally asymmetric multifocal intraocular lens with +1.5 diopters near addition. Sci Rep. 2019 Sep 11;9(1):13117.
19. Kretz FT, Khoramnia R, Attia MS, Koss MJ, Linz K, Auffarth GU. Clinical Evaluation of Functional Vision of +1.5 Diopters near Addition, Aspheric, Rotational Asymmetric Multifocal Intraocular Lens. Korean J Ophthalmol. 2016 Oct;30(5):382-389.
20. Pedrotti E, Mastropasqua R, Bonetto J et al. Quality of vision, patient satisfaction and long-term visual function after bilateral implantation of a low addition multifocal intraocular lens. Int Ophthalmol. 2018 Aug;38(4):1709-1716.
21. Jing-Jing Q, Qian Z, Shu-Hua F et al. A comparison of the visual performance of refractive rotationally asymmetric multifocal intraocular lenses and trifocal intraocular lenses. Materials Express. 2023 Jun;13(6):1110-1115.