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Visual function and complications after cataract surgery with bilateral multifocal intraocular lens implantation

Funkcja wzroku i powikłania po obuocznej operacji zaćmy i wszczepie refrakcyjnych soczewek wieloogniskowych

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Summary: Purpose: To evaluate the visual function and complications after cataract surgery with bilateral Array SA 40N multifocal intraocular lens (IOL) implantation.
Material and methods: This prospective study comprised 40 eyes of selected 20 patients undergoing cataract surgery with bilateral implantation of Array SA 40N (AMO). multifocal IOL. Three months after bilateral surgery distance and near visual acuity, contrast sensitivity, complications and adverse effects were evaluated. Patients' satisfaction was assessed using a subjective TyPE Questionnaire.
Results: Thirty-five eyes (35/40 – 87.5%) achieved the uncorrected distance visual acuity 20/40 and the uncorrected near visual acuity of J5 or better. Eighty-two and a half percent of the operated eyes achieved UCDVA 20/20 and J4 or better. Contrast sensitivity for distance and near measured binocularly were within normal limits, although for higher spatial frequency, contrast sensitivity values for near were slightly above the lower limit of normal range. Intraoperative and postoperative complications were few and only in one eye, further surgical intervention was necessary (IOL recentration). Three patients (3/20 – 15%) reported moderate glare and halo. Overall visual satisfaction measured with TyPE Questionnaire was very high (8.7/10).
Conclusions: Bilateral multifocal IOL implantation was effective and safe in selected cataract patients, providing very good uncorrected distance and near visual acuity. Slightly reduced contrast sensitivity and increased perception of glare/halo were an acceptable compromise for near, as well as distance vision improvement.

Słowa kluczowe: operacja zaćmy, wszczep soczewki wieloogniskowej, funkcja wzroku, powikłania
Key words: cataract surgery, multifocal IOL implantation, visual function, complications.

Introduction

Recently the most common intraocular lens implanted during cataract surgery is monofocal intraocular lens (IOL). It has a single focal distance and therefore the patient has to wear glasses to focus at near distances. Various possibilities have been proposed to give patients good distance, intermediate and near vision like accommodating (1) and multifocal IOL. Refractive as well as diffractive multifocal IOL have the most success in restoring functional vision after modern cataract surgery (2,3).

This study was designed to evaluate the visual function and complications after cataract surgery with bilateral, refractive, multifocal, intraocular Array SA 40N lens implantation.

Patients and methods

The prospective study included 40 eyes of 20 patients (mean of age: 53.8 years ± 10.6; 12 women, 8 men) with cataract (LOCS – NO1/NC1 – 27.5%; NO2/NC2 –37.5%; NO3/NC3 – 32.5%; NO4/NC4 – 2.5%) whom bilaterally implanted AMO Array multifocal SA 40N IOL (Fig. 1).

This is a silicone, zonal – progressive, refractive lens with monofilament haptics (polymethylmethacrylate). It consists of 5 concentric rings alternating between distant-dominant zones (1,3,4) and near-dominant zones (2,5) with a +3.5 diopter add. This lens provides intermediate acuity for distances from 50 to150 cm, as well.

Patient's selection criteria for multifocal IOL are shown in Table I.

Before the patients had extracapsular cataract extraction by phacoemulsification and posterior multifocal IOL implantation, the known information from the literature were given about advantages and disadvantages of the Array multifocal IOL.

- range of age: 40-70 years
- bilateral cataract
- preoperative keratometric cylinder less than 1.5 D
- no preexisting pathology other than cataract
- patient's motivation for spectacle independence
- knowledge about the possibility of postoperative visual aberrations (halo/glare at night)
- no patients whose occupation is night driving and with high demands on vision and near work (e.g. engineers and architects)

Tab. I. Patient's selection criteria for multifocal IOL.
Tab. I. Kryteria doboru pacjentów do wszczepu soczewek wieloogniskowych.

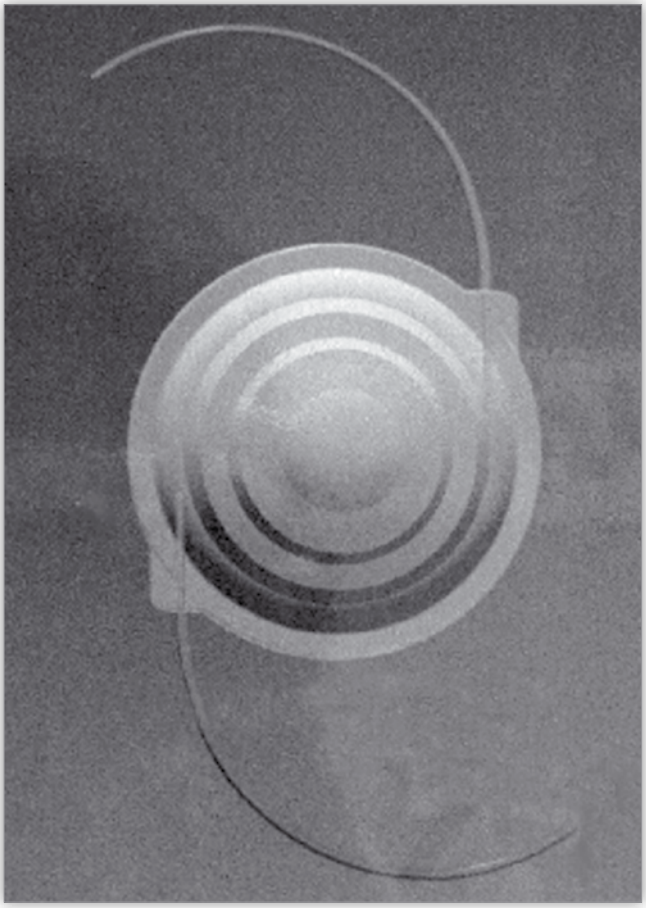

Fig. 1. Illustration of the Array SA 40N IOL with zonal progressive design.
Ryc. 1. Soczewka Array SA 40N z widocznymi strefami optycznymi do dali i bliży.

For IOL power calculation SRK/T or Hoffer Q formulas were used. The refractive target were emmetropia or low hyperopia (0 to + 0.5 D).

Cataract surgery (divide and conquer or phacoaspiration technique for lens extraction) was performed by one surgeon in topical anesthesia (Alcaine) through temporal, clear corneal incision (2.8 – 3.0 mm). Capsulorrhexis diameter was approximately 5.0 mm. Multifocal IOL was implanted using an unfolder. The second eye was operated 1 month after the first one.

Preoperative and postoperative (three months after surgery) ophthalmic evaluation was performed including: uncorrected and best corrected distance and near visual acuity at 30 cm (UCDVA, BCDVA – Snellen Chart; UCNVA, BCNVA – Jaeger Chart), anterior segment evaluation by slit lamp biomicroscopy, intraocular pressure measurement, funduscopy, corneal topography (Humphrey Atlas 993), photopic (an illumination of 85 cd/m2), contrast sensitivity for distance with and without glare (CSV 1000), and near (Functional Acuity Contrast Test – F.A.C.T.), with spatial frequency 1.5, 3, 6, 12, and 18 cycles per degree, postoperative complications and adverse effects.

Patients' satisfaction was assessed using a subjective TyPE Questionnaire.

The visual acuity results and astigmatism before and 3 months after surgery were compared using Wilcoxon test. Statistical significance was set at $p < 0.05$.

Results

The mean preoperative sphere was + 1.13 ± 1.48 D, (range -5.0 to + 4.5 D). The mean cylinder was + 0.60 ± 0.39 D (range 0 to +1.5 D). Three months after surgery the mean sphere was + 0.14 ± 0.35 D (range -1.0 to +1.0 D), the mean cylinder was + 0.70 ± 0.39 D (range 0 to +1.38 D).

Before and after the surgery, the difference in the mean corneal astigmatism was not statistically significant. The distribution of corneal astigmatism before and 3 months after surgery is shown in Fig. 2.

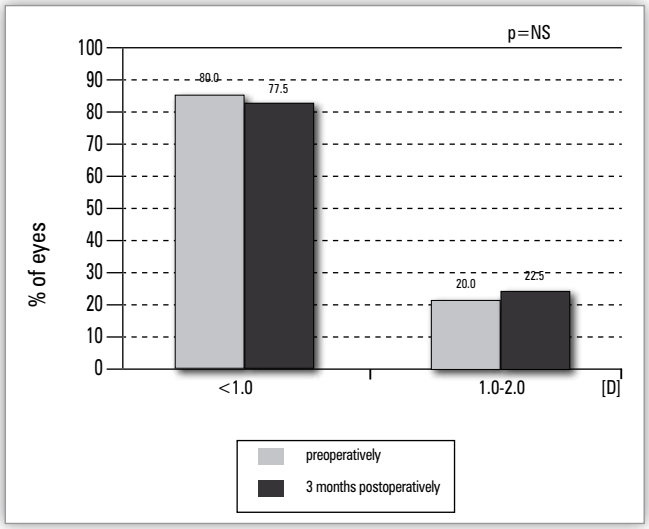

Fig. 2. The percentage distribution of corneal astigmatism before and 3 months after surgery.
Ryc. 2. Procentowy rozkład astygmatyzmu rogówkowego przed zabiegiem i 3 miesiące po zabiegu.

Distribution of refractive error in eyes implanted with the Array multifocal IOL is presented in Fig. 3.

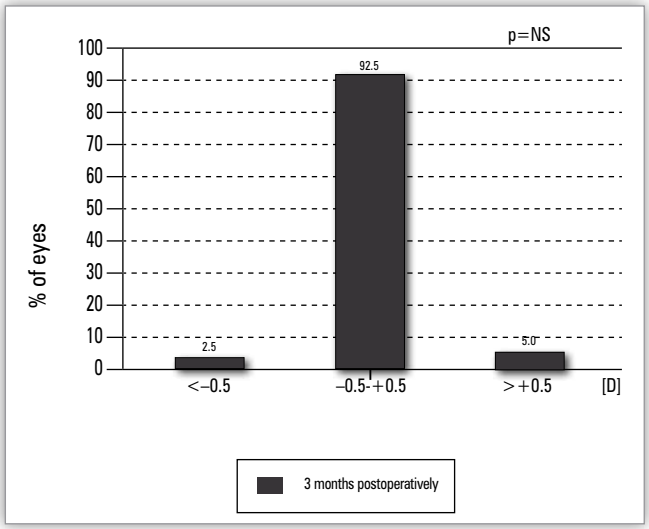

Fig. 3. Distribution of refractive error in eyes implanted with the Array multifocal IOL.
Ryc. 3. Rozkład wad refrakcji w oczach z wszczepioną soczewką wieloogniskową Array.

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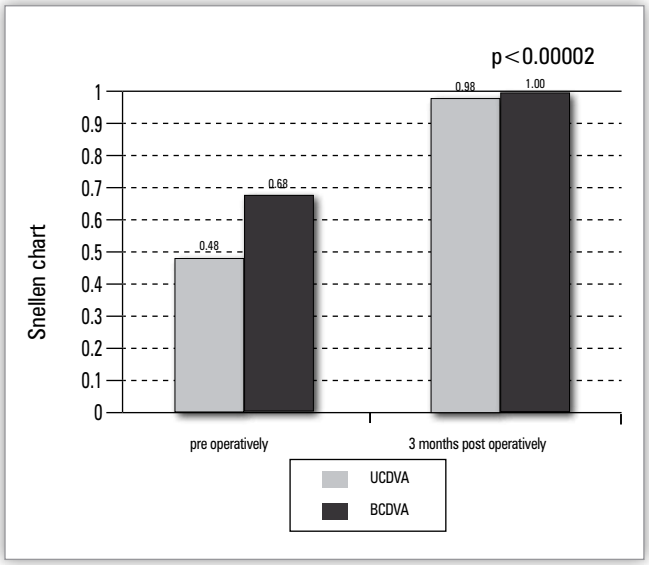

Fig. 4a. Mean distance visual acuity uncorrected (UCDVA) and best corrected (BCDVA) before and 3 months postoperatively.
Ryc. 4a. Średnia nieskorygowana ostrość wzroku do dali (UCDVA) i najlepiej skorygowana ostrość wzroku do dali (BCDVA) przed zabiegiem i 3 miesiące po zabiegu.

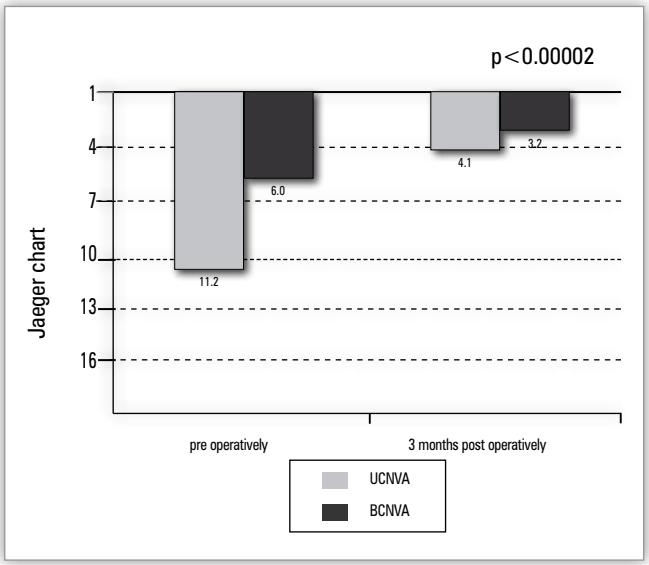

Fig 4b. Mean near visual acuity uncorrected (UCNVA), and best corrected (BCNVA,) before and 3 months postoperatively.
Ryc. 4b. Średnia nieskorygowana ostrość wzroku do bliży (UCNVA) i najlepiej skorygowana ostrość wzroku do bliży (BCNVA) przed zabiegiem i 3 miesiące po zabiegu.

Three months after implantation of multifocal IOL the refractive error in 92.5 % (37/40) of the operated eyes was found to be between -0.5 and +0.5 D.

Mean uncorrected and best corrected distance and near visual acuity before and 3 months after cataract phacoemulsification with the multifocal IOL implantation are shown in Fig. 4a, Fig. 4b.

Three months postoperatively mean visual acuity (uncorrected and best corrected for distance and near,) were significantly better (UCDVA: $p < 0.000001$; UCNVA: $p < 0.00006$; BCDVA: $p < 0.00002$; BCNVA $p < 0.0002$).

The cumulative UCDVA and UCNVA 3 months after bilateral multifocal IOL implantation are shown in Fig. 5.

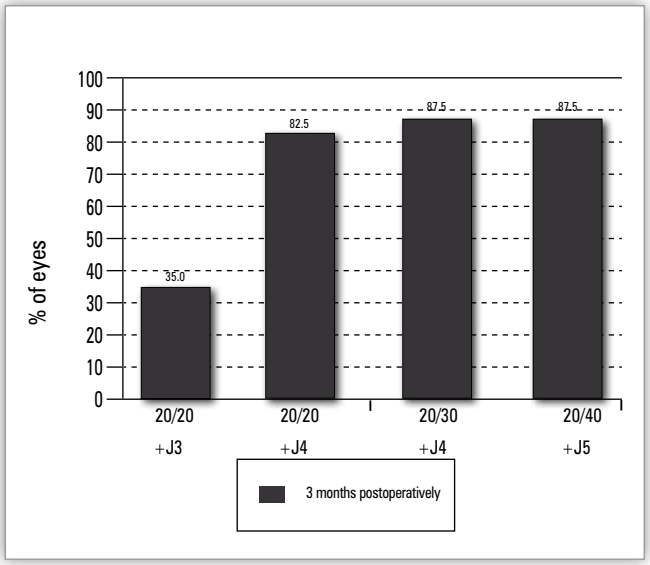

Fig. 5. The cumulative percentage of UCDVA and UCNVA 3 months after bilateral multifocal IOL implantation.
Ryc. 5. Skumulowany rozkład procentowy UCDVA I UCNVA 3 miesiące po obuocznym wszczepieniu soczewek wewnątrzgałkowych wieloogniskowych.

The UCDVA of 20/40 or better and UCNVA of J5 or better was achieved in 87.5 % (35/40) of analyzed eyes.

All eyes obtained BCDVA of 20/20 and BCNVA of J4 or better.

82.5% of the operated eyes achieved UCDVA 20/20 and J4 or better.

Mean best corrected distance, contrast sensitivity without and with glare, measured binocularly was within the normal range and were significantly better ($p < 0.03$; $p < 0.02$) than measured separately for RE, LE (Fig. 6a, Fig. 6b).

Mean best corrected near contrast sensitivity measured binocularly was also within the normal range, although for higher spatial frequency (12, 18 cpd) contrast sensitivity values were near the lower limit of normal range.

Mean best corrected near contrast sensitivity measured binocularly was significantly better ($p < 0.03$), than measured separately for RE, LE (Fig. 6c).

There were not serious intra– and postoperative complications (Table II).

• iritis	0
• elevated intraocular pressure	1 eye
• rupture of the posterior capsule	1 eye
• decentration of the IOL	1 eye
• macular edema	0
• retinal detachment	0
• endophthalmitis	0
total:	3 / 40 eyes

Tab. II. Intraoperative and postoperative complications.
Tab. II. Powikłania śródoperacyjne i pooperacyjne.

Intraoperative and postoperative complications were few and only in one eye, further surgical intervention (IOL recentration), appeared necessary.

The results of the patients' satisfaction are shown in Table III.

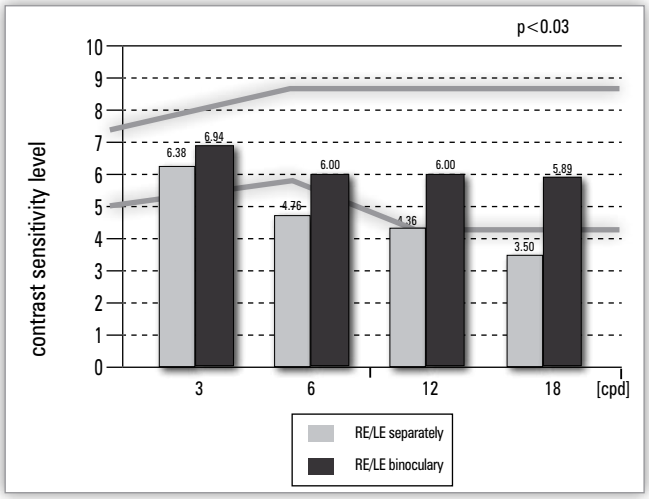

Fig. 6a. Mean best corrected distance contrast sensitivity level without glare.
Ryc. 6a. Średnia czułość kontrastowa w najlepszej korekcji do dali bez olśnienia.

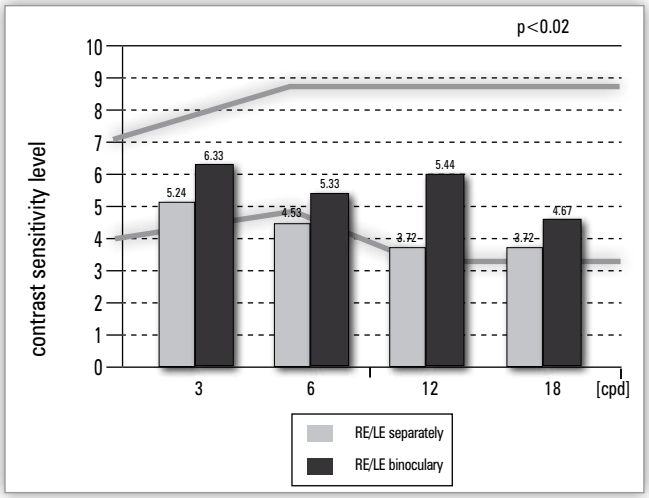

Fig. 6b. Mean best corrected distance contrast sensitivity level with glare.
Ryc. 6b. Średnia czułość kontrastowa w najlepszej korekcji do dali z olśnieniem.

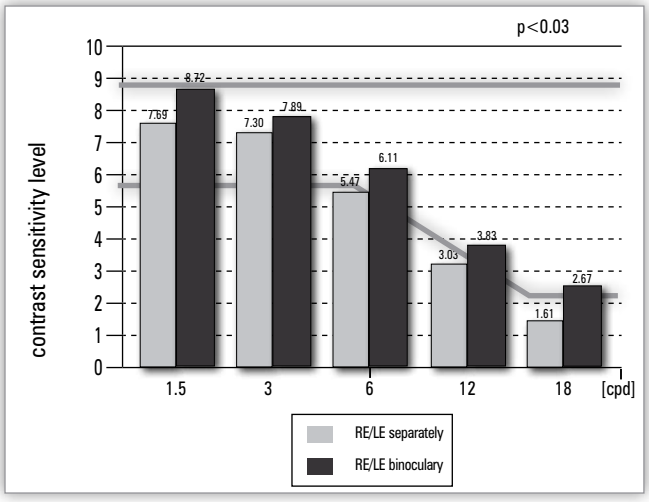

Fig. 6c. Mean best corrected near contrast sensitivity level.
Ryc. 6c. Średnia czułość kontrastowa w najlepszej korekcji do bliży.

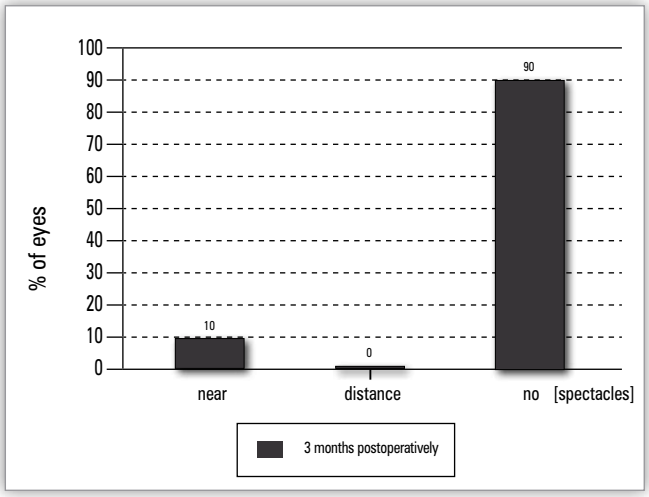

Fig. 7. Spectacle independence for distance and near.
Ryc. 7. Niezależność od korekcji okularowej do dali i bliży.

Patients' general satisfaction was very high (8.7/10). Three patients (3/20 – 15%) reported work difficulties connected with glare /halo but the level of perception was low. What is worth note 90% of patients was spectacle-independent for near and distance (Fig. 7).

• General vision satisfaction	(0-10)	8.7
• Distance vision satisfaction	(0-10)	9.5
• Near vision satisfaction	(0-10)	7.8
• Work difficulty in the near	(0-4)	1.0
• Work difficulty in the distance	(0-4)	0.2
• Work difficulty connected with 'glare/halo'	(0-4)	0.5
• Level of 'glare/halo' perception	(0-4)	0.75

Tab. III. The results of postoperative patients' satisfaction TyPE Questionnaire.
Tab. III. Wyniki pooperacyjnego zadowolenia pacjentów oceniane kwestionariuszem TyPE.

Discussion

At a mean follow-up of 3 months after surgery, all the patients gained better visual acuity. The implantation of the foldable IOL through 2.8 -3.0 mm did not induce significant astigmatism. The astigmatism did not affect the postoperative visual acuity in any case (Fig. 2).

In our study UCDVA of 20/40 and UCNVA of J5 or better received 87.5% (35/40) of eyes (Fig 5). Our functional results are near data described by other authors. In Pineda-Fernandez et al. (5) study, all eyes achieved an uncorrected distance visual acuity of 20/40 or better and an uncorrected near acuity of J5 or better. Packer et al. (4) reported that 94.1% of eyes achieved 20/40 and J5 visual acuity at distance and near. Javitt and Steinert (6) reported that 96% of eyes achieved 20/40 or better distance acuity and J3 or better near acuity.

Although multifocal IOLs provide the ability to read comfortably and see at the distance without glasses, their implantation can be a cause of contrast sensitivity loss. Heo et al. (7) noted

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the patients with AMO Array IOL implantation had reduced contrast sensitivity.

Lee J.M. et al. (8) reported the contrast sensitivity being significantly reduced for nocturnal vision. Montes-Mico and Alio (9) proved that contrast sensitivity was diminished at 12 cpd and 18 cpd 3 months after surgery. Lee E.S. et al. (10) study showed that contrast sensitivity measured 3 months postoperatively was only slightly below the normal range at 3, 6, and 9 cpd. On the contrary Kim et al. (11) and Bleckmann at al. (12) achieved contrast sensitivity values within the normal range. Our results of contrast sensitivity measurements are consistent with Kim and Bleckman studies results (Fig. 6a,b). We obtained slightly reduced contrast sensitivity for distance and near when CS was measured for RE, LE separately but CS was within normal range when was measured from both eyes simultaneously, although for higher spatial frequencies CS was near lower limit of normal range.

Our CS results strongly suggest that multifocal implantation gives the best results if it is performed in both eyes. In special circumstances like unilateral traumatic cataract in young patient multifocal implantation is not contraindicated even though CS for near and distance is below or near lower limit of normal. AMO Array can be employed for the visual rehabilitation in these cases improving near vision while not impairing distance vision as compared with monofocal IOL (2).

It is difficult to compare our patients' satisfaction results with data published in other studies because of different questionnaires. Patients' satisfaction results we compared with data from Leyland et al. study (13), using the same test TyPE Questionnaire responses (binocular unaided vision). In our multifocal group (Table III), patients' satisfaction was almost the same and was very high like in Leyland study. Only 15% of analyzed patients reported work difficulties connected with glare/halo and level of perception of these unwanted phenomena was low (Table III). The frequency of glare/halo is comparable to data described by other authors (6) However, none of our patients needed pupil reduction by 0.5% pilocarpine to reduce halos (14) and none wanted IOL exchange for a monofocal IOL because they were very satisfied with their distance and near acuity.

Many authors described in multifocal group problems with driving at night, so multifocal IOL is contraindicated in professional drivers because of the increased limitation in night vision (14). It was no problem in our group of patients; they were mainly older women that in our country usually do not drive a car, so it was not a problem for them.

In our multifocal group 90% (18/20 patients) (Fig. 7) never needed glasses for distance and near vision. This very good result is better than described by others (Leyland – 24%, Lee – 70%, Pineda – Fernandez 31%). One of the explanations might be very accurate selection of the patients for multifocal IOL, good power calculation of IOL, meticulous surgery and patients not to old with good brain plasticity giving possibility for quick neuroadaptation for new optic conditions. We received an excellent distribution of refractive error after multifocal IOL implantation (Fig. 3). In almost 93% of analyzed eyes, postoperative refraction was within $\pm$ 0.5D. This result is much better than those described in Lee E.S., Centurion (15) or Pineda-Fernandez study (61.0%; 76.7%; 56.0% respectively). This difference may partially result for different formula and systems used for IOL calculation (USG method or laser interferometry method), experience of physician performing IOL calculation, differences in the target refraction among different investigators. When choosing IOL power our target was emmetropia or low hyperopia whereas for example in the study by Lee E.S. et al. (10), the target refraction was myopia closest to emmetropia.

In our series of eyes with multifocal IOL implantation, there was not serious intra- and postoperative complications (Table II). In one eye rupture of posterior capsule appeared and the lens was implanted into the ciliary sulcus. The lens power was adjusted to -0.5 D less than the value of the power calculation. In the first day after surgery lens decentration was observed. After recentration of this lens visual acuity for distance and near was 20/20 and J4 respectively. It is worth to know that the three pieces AMO Array IOL, opposite to one-piece diffractive Restore lens (Alcon), may be possibly placed in the ciliary sulcus (16). It is a very important advantage in complicated cases especially in patients with previously implanted multifocal IOL in one eye.

In conclusion our first experiences with bilateral multifocal IOL implantation suggest that this procedure is effective and safe in selected cataract patients, providing very good uncorrected distance and near visual acuity. Slightly reduced contrast sensitivity and increased perception of glare/halo were an acceptable compromise for near as well as distance vision improvement.

REFERENCES:

1. Macsai MS, Padnick-Silver L, Fontes BM: *Visual outcomes after accommodating intraocular lens implantation.* J Cataract Refract Surg 2006, 32, 628-33.
2. Belluci R: *Multifocal intraocular lenses*. Current Opinion in Ophthalmology 2005, 16, 33-37.
3. Lane SS, Morris M, Nordan L, Packer M, Tarantino N, Wallace RB: *Multifocal intraocular lenses*. Ophthalmol Clin North Am 2006, 19, 89-105.
4. Packer M, Fine IH, Hoffman RS: *Refractive lens exchange with the Array multifocal intraocular lens.* J Cataract Refract Surg 2002, 28, 421-424.
5. Pineda-Fernandez A, Jaramilli J, Celis V, Vargas J, DiStacio M, Galindez A, Del Valle M: *Refractive outcome after bilateral multifocal intraocular lens implantation.* J Cataract Refract Surg 2004, 30, 685-688.
6. Steinert R, Aker B, Trentacost D, Smith P, Tarantino N: *A Prospective Comparative Study of the AMO ARRAY Zonal – Progressive Multifocal Silicone Intraocular Lens and a Monofocal Intraocular Lens.* Ophthalmology 1999, 106, 1243-1255.
7. Heo JY, Kim YH, Joo CK: *Clinical results of AMO ARRAY multifocal intraocular lens.* J Korean Ophthalmol Soc 1999, 40, 978-986.
8. Lee JM, Seo KR, Kim EK: *Comparison of optical aberrations and contrast sensitivity between monofocal and multifocal intraocular lens.* J Korean Ophthalmol Soc 2002, 10, 1882-1886.
9. Montes-Mico R, Alio JL: *Distance and near contrast sensitivity function after multifocal intraocular lens implantation.* J Cataract Refract Surg 2003, 29, 703-711.

10. Lee ES, Lee SY, Jeong SY, Moon YS, Chin HS, Cho JS, Oh JH: Effect of postoperative refractive error on visual acuity and patients satisfaction after implantation of the Array multifocal intraocular lens. J Cataract Refract Surg 2005, 31, 1960-1965.
11. Kim JH, Kim HB, Lim SJ: *Clinical results of AMO ARRAY multifocal intraocular lens.* J Korean Ophthalmol Soc 2001, 42, 709-712.
12. Bleckmann H, Schmidt O, Sunde T, Kaluzny J: *Visual results of progressive multifocal posterior chamber intraocular lens implantation*. J Cataract Refract Surg 1996, 22, 1102-1107.
13. Leyland MD, Langan L, Goolfee F, Lee N, Bloom PA: *Prospective randomized double – masked trial of bilateral multifocal, bifocal or monofocal intraocular lenses*. Eye 2002, 16, 481-490.
14. Hunkeler JD, Coffman TM, Paugh J et al.: *Characterization of visual phenomena with the Array multifocal intraocular lens.* J Cataract Refract Surg 2002, 28, 1195-1204.
15. Centurion VA: *A visual performance with AMO Array multifocal refractive intraocular lens.* In Agarwal S, Agarwal A, Pallikaris IG et al, eds, Refractive Surgery. New Dehli, Jaypee Brothers, 2000, 526-532.
16. Aralikatti AK, Tu KL, Kamath GG, Philips RP, Prasad S: *Outcomes of sulcus implantation of Array mutifocal intraocular lenses in second – eye cataract surgery complicated by vitreous loss.* J Cataract Refract Surg 2004, 30, 155-160.

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